FORM PTO-1390 (REV. 5-93)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 10191/1974

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known, see 37 CFR 1 5)

09/914982

INTERNATIONAL APPLICATION NO. PCT/DE00/00134	INTERNATIONAL FILING DATE (15.01.00) 15 January 2000	PRIORITY DATE(S) CLAIMED (05.03.00) 05 March 2000

TITLE OF INVENTION
METHOD AND DEVICE FOR DETERMINING A DISPLACEMENT OF IMAGES IN AN IMAGE SEQUENCE

APPLICANT(S) FOR DO/EO/US

Andreas ENGELSBERG

Applicant(s) herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S C. 371.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.

3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))

   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).

   b. ☒ has been transmitted by the International Bureau.

   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)

6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))

   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).

   b. ☐ have been transmitted by the International Bureau.

   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.

   d. ☒ have not been made and will not be made.

8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S C. 371(c)(3)).

9. ☒ An oath or declaration of the inventor(s) (35 U.S C. 371(c)(4)) (unsigned).

10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3 28 and 3.31 is included.

13. ☒ A **FIRST** preliminary amendment.

   ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.

14. ☒ A substitute specification and a marked up version thereof.

15. ☐ A change of power of attorney and/or address letter.

16. ☒ Other items or information: International Search Report; International Preliminary Examination Report; and Form PCT/RO/101 (English Translations)

Express Mail No. EL244508494

U.S. APPLICATION NO if known, see 37 C.F.R.1.5 **09/914982**	INTERNATIONAL APPLICATION NO PCT/DE00/00134	ATTORNEY'S DOCKET NUMBER 10191/1974

17. ☒ The following fees are submitted·

Basic National Fee (37 CFR 1.492(a)(1)-(5)):
Search Report has been prepared by the EPO or JPO $860.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) . $690.00

No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $710.00

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,000 00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100 00

	CALCULATIONS	PTO USE ONLY
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1 492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	22 - 20 =	2	X $18.00	$ 36	
Independent Claims	2 - 3 =	0	X $80.00	$ 0	
Multiple dependent claim(s) (if applicable)			+ $270 00	$ 0	

	CALCULATIONS	PTO USE ONLY
TOTAL OF ABOVE CALCULATIONS =	$ 896	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).	$	
SUBTOTAL =	$ 896	
Processing fee of $130 00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +	$	
TOTAL NATIONAL FEE =	$ 896	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3 28, 3.31). $40.00 per property +	$	
TOTAL FEES ENCLOSED =	$ 896	
	Amount to be: refunded	$
	charged	$

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. _11-0600_ in the amount of $896.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. _11-0600_. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1 495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO.

_____
SIGNATURE

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New York, New York 10004
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Richard L. Mayer, Reg No. 22,490
NAME

9/5/2001
DATE

405384

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s)	:	Andreas ENGELSBERG
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	METHOD AND DEVICE FOR DETERMINING A DISPLACEMENT OF IMAGES IN AN IMAGE SEQUENCE
Art Unit	:	To Be Assigned
Examiner	:	To Be Assigned

Assistant Commissioner
  for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT AND
37 C.F.R. § 1.125 SUBSTITUTE SPECIFICATION STATEMENT

SIR:

Please amend without prejudice the above-identified application before examination, as set forth below.

IN THE TITLE:

Please amend without prejudice the title to be:

--METHOD AND DEVICE FOR DETERMINING A DISPLACEMENT OF IMAGES IN AN IMAGE SEQUENCE--.

IN THE SPECIFICATION AND ABSTRACT:

In accordance with 37 C.F.R. § 1.121(b)(3), a Substitute Specification (including the Abstract, but without claims) accompanies this response. It is respectfully requested that the Substitute Specification (including Abstract) be entered to replace the Specification of record.

IN THE CLAIMS:

Without prejudice, please cancel original claims 1 to 13, and please add new claims 14 to 35 as follows:

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--14. (New) A method for determining a displacement of images in an image sequence for compensating for a camera movement, a plurality of image regions of the images being available for determining the displacement, each of the plurality of image regions being provided at a preselected position of the images, and each of the plurality of image regions having preselected dimensions, in which there are predetermined numbers of pixels in various directions of the image, and for separating an image movement mainly caused by a camera movement from an additional movement, which is superimposed on the image movement in subregions of an image to be corrected, the method comprising:

determining a probability of the image movement occurring without the additional movement at different positions of an image;

specifying and fixing, for each of the plurality of image regions, a position and dimensions as a function of the probability of the image movement occurring inside at least one image region of the plurality of image regions without the additional movement; and

determining the displacement by preferentially using the at least one image region of the plurality of image regions.

15. (New) The method of claim 14, wherein:

the method includes:

correcting a first image of the image sequence by determining the displacement from one of (i) first image data of the first image of the image sequence and second image data of a second image of the image, and (ii) the first image data of the first image of the image sequence and starting image data of a starting image sequence; and

determining a regional displacement of the at least one image region of the plurality of the image regions is determined from one of (i) the first image data of the first image and the second image inside the at least one image region, and (ii) the first image data of the first image and the second starting image inside the at least one image region; and

the step of determining the displacement uses the regional displacement of the at least one image region of the plurality of image regions as the displacement.

16. (New) The method of claim 14, wherein the position and the dimensions of at least one first image region are selected so that the at least one first image region of images to be corrected is mainly filled in by an image background.

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17. (New) The method of claim 14, wherein the position and the dimensions of at least one second image region are selected so that the at least one second image region of images to be corrected is mainly filled in by an image foreground.

18. (New) The method of claim 15, wherein at least one of at least one first image region and at least one second image region is used as a function of a reliability factor for determining the regional displacement to determine the displacement.

19. (New) The method of claim 15, wherein:

two first image regions and one second image region are available for image correction; and

the displacement is determined from one of the following, in a descending priority order:

a mean of regional displacements of the two first image regions, when a reliability of the regional displacement determinations for the two first image regions is considered sufficient;

a regional displacement of one of the two first image regions, when a reliability of the regional displacement determination is considered sufficient; and

a regional displacement of the second image region.

20. (New) The method of claim 19, wherein the method is used for a head-shoulder recording situation, the method further comprising:

selecting the two first image regions to be in a lateral region to the left and right of a vertical center line of a predetermined rectangular image;

selecting a distance of the two first image regions from a bottom image margin to be greater than another distance of the two first image regions from a top image margin; and

selecting the second image region to be near a center of the image.

21. (New) The method of claim 18, wherein determined regional displacements and reliability factors of the determined regional displacements for two image regions are determined by:

determining a regional displacement and a correlation quotient for each of the two image regions;

determining a threshold value function as a function of the regional displacement of each of the two image regions;

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comparing a determined correlation quotient of one of the two image regions to a threshold value resulting from the threshold value function for a regional displacement of another of the two image regions; and

determining the reliability factor of the determined regional displacement of each of the two image regions to be sufficient when the determined correlation quotient corresponding to the one of the two image regions is greater than the threshold value of the threshold value function compared to the determined correlation quotient.

22. (New) The method of claim 21, wherein the determined correlation quotient of one of the two image regions is determined by:

using block-matching to determine displacement correlation values for a plurality of possible regional displacements;

determining a regional displacement having a maximum displacement correlation value to be the regional displacement of the image regions; and

determining the correlation quotient by dividing the maximum displacement correlation value by a mean of determined displacement correlation values.

23. The method of claim 21, wherein:

the threshold value function assumes a value of a preselected second threshold value by for each arbitrary regional displacement less than a preselected first threshold value;

the threshold value function assumes a value of the preselected second threshold value minus a product for each arbitrary regional displacement greater than the preselected first threshold value;

the product includes a preselected slope parameter and a difference as factors; and

the difference being formed from the arbitrary regional displacement and the preselected first threshold value.

24. (New) The method of claim 18, wherein for each of the image regions, the regional displacement is determined using block-displacement information from a block-based encoding process by considering the block-displacement information of blocks lying inside a specific image region.

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25. (New) The method of claim 24, wherein for each of the image regions, the regional displacement, including a horizontal component and a vertical component, and the reliability factor of a determined regional displacement are determined by:

determining the horizontal component of the regional displacement by generating a first frequency distribution for frequencies of different values of the horizontal component of the block-displacement information, the horizontal component of the regional displacement corresponding to a value of the horizontal component of the block-displacement information, at which the first frequency distribution assumes its principal maximum;

determining the vertical component of the regional displacement by generating a second frequency distribution for frequencies of different values of the vertical component of the block-displacement information, the vertical component of the regional displacement corresponding to a value of the vertical component of the block-displacement information, at which the second frequency distribution assumes its principal maximum;

determining the reliability factor of the determined regional displacement to be sufficient when all of the following conditions are satisfied:

an absolute value of a difference in position of values of the horizontal component of the block-displacement information, corresponding to the principal maximum and a secondary maximum of the first frequency distribution, is less than a preselected first difference threshold;

the absolute value of a difference in position of values of the vertical component of the block-displacement information, corresponding to the principal maximum and a secondary maximum of the second frequency distribution, is less than a preselected second difference threshold;

the principal maximum of the first frequency distribution is greater than a first frequency threshold; and

the principal maximum of the second frequency distribution is greater than a second frequency threshold.

26. (New) A device for determining a displacement of images in an image sequence, the device comprising:

a displacement-detection arrangement to perform a process for determining the displacement of images in the image sequence for compensating for a camera movement, a plurality of image regions of the images being available for determining the displacement, each of the plurality of image regions being provided at a preselected position of the images, and each

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of the plurality of image regions having preselected dimensions, in which there are predetermined numbers of pixels in various directions of the image, and for separating an image movement mainly caused by a camera movement from an additional movement, which is superimposed on the image movement in subregions of an image to be corrected, the process including:

determining a probability of the image movement occurring without the additional movement at different positions of an image;

specifying and fixing, for each of the plurality of image regions, a position and dimensions as a function of the probability of the image movement occurring inside at least one image region of the plurality of image regions without the additional movement; and

determining the displacement by preferentially using the at least one image region of the plurality of image regions.

27. (New) The method of claim 15, wherein the second image data of the second image of the image sequence precedes directly the first image.

28. (New) The method of claim 15, wherein the starting image data of the starting image of the image sequence precedes directly the first image.

29. (New) The method of claim 20, wherein the two first image regions are selected to be in the lateral region to the left and right of the vertical center line of the predetermined rectangular image, and symmetrical to the vertical center line.

30. (New) The method of claim 20, wherein the second image region is selected to be near the center of the image, and symmetric to the vertical center line of the rectangular image.

31. (New) The method of claim 29, wherein the second image region is selected to be near the center of the image, and symmetric to the vertical center line of the rectangular image.

32. (New) The method of claim 31, wherein the distance of the second image region from the top image margin is selected to be greater than the distance of the second image region from the bottom image margin.

33. (New) The method of claim 20, wherein the distance of the second image region from the top image margin is selected to be greater than the distance of the second image region from the bottom image margin.

34. (New) The method of claim 21, wherein the two image regions include the two first image regions.

35. (New) The method of claim 24, wherein the block-displacement information includes displacement vectors.--.

Remarks

This Preliminary Amendment cancels without prejudice original claims 1 to 13 in the underlying PCT Application No. PCT/DE00/00134, and adds without prejudice new claims 14 to 35. The new claims conform the claims to U.S. Patent and Trademark Office rules and do not add new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. § 1.121(b)(3)(iii) and § 1.125(b)(2), a Marked Up Version Of The Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. In the Marked Up Version, underlining indicates added text and bracketing indicated deleted text. Approval and entry of the Substitute Specification (including Abstract) is respectfully requested.

The underlying PCT Application No. PCT/DE00/00134 includes an International Search Report, dated June 20, 2000. The Search Report includes a list of documents that were uncovered in the underlying PCT Application. A copy of the Search Report accompanies this Preliminary Amendment.

The underlying PCT application also includes an International Preliminary Examination Report, dated June 26, 2001. An English translation of the International Preliminary Examination Report accompanies this Preliminary Amendment.

Applicant asserts that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Dated: 9/5/2001

Respectfully Submitted,

KENYON & KENYON

By: _____

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[10191/1974]

METHOD AND DEVICE FOR DETERMINING A
DISPLACEMENT OF IMAGES IN AN IMAGE SEQUENCE

FIELD OF THE INVENTION

The present invention relates to a device and method for
determining the displacement of images in an image sequence.

5   BACKGROUND INFORMATION

An image-stabilization system, which is supposed to
substantially stabilize an image while recording with a
camcorder in one's hand, is discussed in the article of H.
Rindtorff, "Bildstabilisation in Consumer-Camcordern, Funktion
10   und Wirkungsweise" ("Image Stabilization in Consumer
Camcorders - Function and Mode of Operation") Fernseh- und
Kinotechnik (Television and Cinema Technology), 49th year, no.
½, 1995.

15   In this context, and as characterized, the image is split up
into four sectors, in which movement vectors describing the
displacement of the image are determined. A total movement
vector, which ideally represents the displacement of the
camera, is determined from the movement vectors of the
20   individual sectors.

SUMMARY OF THE INVENTION

In contrast, it is believed that the exemplary method of the
present invention has the advantage that image regions, which
25   are specially used in the sections of an image to determine
the displacement of the images, are distinguished by as high
probability as possible, of the image movement occurring
without the additional movement. In this way, it is believed
that the displacement of images of an image sequence may be
30   determined in a particularly reliable manner. In addition, it
is believed that this is conducive to reliably determining the

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displacement of images in an image sequence, when the position
and the dimensions of the image regions are fixed.

It is believed that this may especially allow the displacement

5   to be reliably determined for a special scenario of moving
picture communication (full-motion video), using relatively
little processing time. A first image region, which may be
preferentially used from the plurality of image regions to
determine the displacement, may be used alone for determining

10   the displacement, by selecting its position and its dimensions
inside the images, so that other image regions do not have to
be considered, and thus, the processing time for determining
the displacement of images is decreased.

15   It is believed that it may be advantageous that a first image
of the image sequence is corrected by determining the
displacement, either from image data of the first image and
image data of a second image of the image sequence that may
precede the first image directly, or from image data of the

20   first image and image data of a second input image of the
image sequence that may precede the first image directly. A
regional displacement of an image region being used as a
displacement, and the regional displacement of an image region
of the plurality of the image regions either being determined

25   from the image data of the first image and the second image
inside the one image region, or from the image data of the
first image and the second input image inside the one image
region. In this manner, only the image data of the first and
the second images inside the image region, which is used for

30   determining the displacement of the image, are needed for
processing, which means that the processing time may be
reduced.

In addition, it is believed that it may be advantageous that

35   the position and the dimensions of the at least one first
image region are selected so that the at least one first image
region of the images to be corrected is mainly filled in by

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the image background. Since the image background may rarely exhibits additional movements from one image to another image, between which the displacement should be determined, in which case the additional movements are superimposed on the image

5   movement that is especially caused by the unintentional movement of a camera, a first image region of the images to be corrected may be advantageously used for determining the displacement, when it is filled in by the image background.

10   Furthermore, it is believed that it may be advantageous that the position and the dimensions of at least one second image region are selected in such a manner, that the at least one second image region of the images to be corrected is mainly filled in by the image foreground. This may allow the

15   displacement of images of an image sequence to be determined in an especially simple manner, and with high accuracy, when, for example, the image background is subjected to a sharp, additional movement, which is superimposed on the image movement that may be caused by the unintentional camera

20   movement.

To determine the displacement, it is also believed to be advantageous to use at least one first image region and/or at least one second image region as a function of a margin of

25   reliability (reliability factor), for determining the regional displacement. This allows the determination of the region displacement to be checked, because a measure for the reliability of the regional-displacement determination is available inside the exemplary method. Therefore, the

30   determination of a reliability factor for the regional-displacement determination is primarily used to simply and reliably separate the image movement from the additional movement superimposed on it.

35   Furthermore, it is believed that it may be advantageous that two first image regions and an individual second image region are available for image correction, the displacement being

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determined in one of the following three ways, in the order of
descending priority:

5

- from the mean of the regional displacements of the two
  first image regions, when the reliability factor of the
  regional-displacement determination of the two first
  image sequences is considered to be sufficient;

- from the regional displacement of one of the two first
  image regions, in which the reliability of the
10 regional-displacement determination is considered to be
  sufficient;

- from the regional displacement of the second image
  region.

15 It is believed that this may allow different image regions of
different priority to be used for determining the displacement
of images in an image sequence. In particular, image regions,
which are mainly filled in by the image background, may be
preferentially used for determining the displacement of
20 images. The use of the mean of the regional displacements of
the two first image regions resulting in a reliable
determination of the displacement.

The second priority for determining the displacement, using
25 the regional displacement calculated from the two first image
regions, is especially selected to minimize the influence of
objects moving in the background, since an object moving into
one of the two first image regions leads to the regional
displacement of the other of the two image regions being used
30 for determining the displacement of images in an image
sequence.

On the third level of priority, the displacement of images
from the regional displacement of the second image region,
35 especially from the regional displacement of an image region
that is mainly filled in by the image foreground, is used.

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In addition, it is believed that it may be advantageous that the exemplary method is used for a head-shoulder recording situation, the two first image regions being selected to be in a lateral image region, to the left and right of, and which may be symmetrical to, the vertical center line of a predetermined rectangular image, the distance of the two first image regions from the bottom image margin being selected to be greater than the distance of the two first image regions from the top image margin, the second image region being selected to be near the center of the image, which may be symmetric to the vertical center line of the rectangular image, and the distance of the second image region from the top image margin may be selected to be greater than the distance of the second image region from the bottom image margin.

In the case of a head-shoulder recording situation, such a choice of image regions particularly allows the information from the image regions to be sensibly used for determining the regional displacements, and sensibly used to determine the displacement of images in an image sequence, by prioritizing the use of regional displacements.

In addition, it is believed that it may be advantageous that, for two image regions, which may be the two first image regions, the regional displacement and the reliability of the regional-displacement determination are determined by an exemplary method having the following steps:
-       the regional displacement and a correlation quotient are calculated for each of the two image regions;
-       a threshold value function is determined as a function of each ascertained regional displacement of the two image regions;
-       each correlation quotient of one of the two image regions is compared to the value, which results from a threshold value function for the regional displacement of the other of the two image regions;

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- the reliability of the regional-displacement
determination for each of the two image regions is viewed
as being sufficient, when the correlation quotient
corresponding to the one image region is greater than the

5   value of the threshold-value function to be compared to
the correlation quotient.

In this manner, the reliability factors for the regional
displacement of the two first image regions are not determined

10   independently of each other, but rather the ascertained
regional displacement of one of the two first image regions
determines the value, which the threshold-value function
assumes, and to which the regional displacement of the other
of the two first image regions is compared. Therefore, the

15   regional displacement of one image region and the reliability
factor of the regional displacement are not determined
independently of movements, especially regional displacements,
in other parts of an image.

20   Furthermore, it is believed that it may be advantageous that
the correlation quotient of one of the two image regions is
determined according to an exemplary method having the
following steps:
- using a block-matching method, displacement-correlation

25   values are determined for several possible regional
displacements;
- the regional displacement, for which the
displacement-correlation values are maximized, is
regarded as the regional displacement of the image

30   region;
- the correlation quotient is formed by dividing the
maximum displacement-correlation value by the average
value of the calculated displacement-correlation values.

35   In this manner, the regional displacement is first of all
determined using the entire image region, since the
displacement-correlation values are calculated by forming the

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sum over (of) all the image points of the image region in consideration. Secondly, the correlation quotient is normalized, since the maximum displacement-correlation value, from which the regional displacement results, is divided by

5   the mean of the calculated displacement-correlation values.

In addition, it is believed that it may be advantageous that, for each arbitrary regional displacement less than a preselected first threshold value, the value of a preselected

10   second threshold value is assumed by the threshold-value function, and that, for each arbitrary regional displacement greater than the preselected first threshold value, the value of the preselected second threshold value minus a product is assumed by the threshold-value function. The product

15   including a preselected slope parameter and a difference as factors, and the difference being formed from the arbitrary regional displacement and the preselected first threshold value.

20   It is believed that an advantage of this may be that, for larger, ascertained regional displacements of an image region, the regional displacement is allowed a sufficient margin of reliability, even when the correlation coefficient is smaller, which, in the case of a small, ascertained regional

25   displacement, would indicate a correlation that is not as good. Due to the dependence of the two first image regions in the calculation of the reliability factor for the determination of the regional displacement, the result of the structure of the threshold-value function is that, in response

30   to a relatively large regional displacement of one of the two first image regions, the required reliability of the regional-displacement determination, that is, the required magnitude of the correlation coefficient, may not be as high.

35   In another exemplary method for determining a displacement of images in an image sequence, block-displacement information from a block-based encoding method is used for determining the

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regional displacement. The block-displacement information,
which may be displacement vectors, of blocks lying inside the
specific image region being considered for each of the image
regions. It is believed that this should result in an
5   especially simple and cost-effective implementation of the
exemplary method according to the present invention,
especially when, for example, block-displacement information,
in particular block-displacement vectors, of small image
blocks can be obtained without additional expenditure, or with
10   only a small amount of additional expenditure.

In addition, an exemplary method according to the present
invention implements the following steps for each of the image
regions, to determine the regional displacement that has a
15   horizontal and vertical component, and to calculate the
reliability factor of the regional-displacement determination.
     -      To calculate the horizontal component of the regional
            displacement, a first frequency distribution is generated
            for the frequencies of different values of the horizontal
20   components of the block-displacement information, the
            horizontal component of the regional displacement
            corresponding to the value of the horizontal component of
            the block-displacement information, at which the first
            frequency distribution assumes its principal (global,
25   absolute) maximum;
     -      to calculate the vertical component of the regional
            displacement, a second frequency distribution is
            generated for the frequencies of different values of the
            vertical components of the block-displacement
30   information, the vertical component of the regional
            displacement corresponding to the value of the vertical
            component of the block-displacement information, at which
            the second frequency distribution assumes its principal
            maximum;
35   -   the reliability of the regional-displacement
            determination is considered to be sufficient, when all of
            the following conditions are fulfilled;

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- the absolute value of the difference in the position
of the values of the horizontal component of the
block-displacement information, which correspond to
the principal maximum and the secondary (local,

5   relative) maximum of the first frequency
distribution, is less than a preselected, first
difference threshold;
- the absolute value of the difference in the position
of the values of the vertical component of the

10   block-displacement information, which correspond to
the principal maximum and the secondary maximum of
the second frequency distribution, is less than a
preselected, second difference threshold;
- the principal maximum of the first frequency

15   distribution is greater than a first frequency
threshold; and
- the principal maximum of the second frequency
distribution is greater than a second frequency
threshold.

20
By considering the frequencies of the occurring, horizontal
and vertical components of the already present
block-displacement information, firstly, the regional
displacement of an image region may be determined, and

25   secondly, the reliability factor of the regional-displacement
determination may be calculated.

The exemplary device of the present invention, which is for
determining a displacement of images in an image sequence, is

30   believed to have the advantage that the displacement can
especially be determined in a quicker and simpler manner by
implementing the exemplary method steps of the exemplary
method according to the present invention, in a microchip or
on a printed circuit board, which should result in the

35   exemplary method of the present invention being carried out in
a quicker and more cost-effective manner.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a block diagram of the exemplary device according to the present invention.

5   Figure 2 shows the principal of image stabilization, by determining a displacement of images in an image sequence.

Figure 3 shows a flowchart for image stabilization.

10   Figure 4 shows an example of selecting image regions inside an image, to implement the exemplary method according to the present invention.

DETAILED DESCRIPTION

15   Figure 1 shows a block diagram of the exemplary device according to the present invention, for determining a displacement of images in an image sequence. The exemplary device includes an input 10, an output 20, a displacement-detection circuit 100, and a magnification

20   circuit 200. Displacement-detection circuit 100 includes a regional-displacement detector 110, an image-storage device (display store) 120, and a microcomputer 130. In addition, displacement-detection circuit 100 includes an input, which is not shown and is connected to input 10 of the exemplary device

25   according to the present invention, to regional-displacement detector 110, and to image-storage device 120.

In addition, displacement-detection circuit 100 includes an output, which is not shown and is connected to microcomputer

30   130. Regional-displacement detector 110 is also connected to microcomputer 130. Magnification circuit 200 includes two inputs not shown and an output, which is connected to output 20 of the exemplary device. The two inputs of magnification circuit 200 are each connected to a magnification processor

35   210, one of the two inputs of magnification circuit 200 being connected to input 10 of the exemplary device, and the other of the two inputs of magnification circuit 200 being connected

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to the output of displacement-detection circuit 100.

Figure 2 shows an example of image stabilization, for example, compensating for camera movements. In this context, a first
5   input image 13 is corrected to form a first output image 23, use being made of image information regarding a second input image 11, which may precede the first input image in time.

Second input image 11 includes an image detail, which is
10   enlarged by magnification to form second output image 21. In this context, second input image 11 is completely recorded by the camera, but a user of the exemplary device may only see the image detail in magnified form, as second output image 21. In this case, the image detail is referred to as second image
15   12, or also as corrected second image 12.

According to another exemplary method of the present invention, corrected second image 12 is used to correct first input image 13. First input image 13 also includes an image
20   detail, which is referred to here as uncorrected first image 14. A displacement 15 can be determined by comparing uncorrected first image 14 to second image 12, that is, to corrected second image 12, so that uncorrected first image 14 can be converted into a corrected first image 16, using
25   displacement 15. In particular, not all of the image data are utilized in comparing uncorrected first image 14 to second image 12, but rather, just the image data from image regions (not shown) of first image 14 and second image 12.

30   According to another exemplary method of the present invention, second image 11 is used to correct first input image 13. Displacement 15 can be determined by comparing first input image 13 to second input image 11, so that uncorrected first image 14 can be converted into corrected first image 16,
35   using displacement 15. In particular, not all of the image data are utilized in comparing first input image 13 to second input image 11, but rather, just the image data from image

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regions (not shown) of first input image 13 and second input image 11.

Corrected first image 16 can now be shown to the user as a first output image 23, in accordance with both the first and second exemplary methods. Compared to the second output image, the displacement of first input image 13 or corrected first image 16 can no longer be observed in first output image 23.

The method steps of the exemplary method according to the present invention are shown in Figure 3 by a flow chart, using the correction of first input image 13 as an example. The regional displacements of image regions are determined in a first sequence step 30. In this connection, first input image 13 is compared to corrected second image 12, which especially precedes it in time, or the first input image is compared to second input image 11, which especially precedes it in time. In sequence step 40, the displacement of first image 14 is subsequently determined in accordance with the exemplary method. In third sequence step 50, uncorrected first image 14 is displaced by displacement vector 15. The result of this operation is corrected first image 16. Subsequently, corrected first image 16 is enlarged in fourth sequence step 60, which results in first output image 23.

To correct a further input image, the result of third sequence step 50 can be made available to first sequence step 30 by storing it, which may be in image-storage device 120. The result of third sequence step 50 is corrected first image 16, which therefore appears in the place of corrected second image 12, and, in connection with the correction of the further input image, is used for determining regional displacements in first sequence step 30.

As an alternative, first input image 13 or uncorrected first image 14 can, together with calculated displacement 15, also be saved in image-storage device 120, to correct an additional

input image.

Figure 4 shows an example of a distribution of image details
6, 7, 8 inside first input image 14. In this context, two
first image regions 6, 7 are selected to be symmetric to the
vertical center line of given, rectangular first image 14,
especially for using the exemplary method of the present
invention in a head-shoulder recording situation. In this
context, the distance of the two first image regions 6, 7 from
the bottom image margin is greater than the distance of the
two first image regions 6, 7 from the top image margin.
A second image region 8 is selected to be near the center of
first image 14, which may be symmetric to the vertical center
line of the rectangular image, the distance of second image
region 8 from the top image margin which may be selected to be
greater than the distance of the second image region from the
bottom image margin.

The exemplary method of the present invention for determining
a displacement 15 of images in an image sequence may be used
for image stabilization, to compensate for camera movements in
consumer video cameras (camcorders). The digital, full-motion
image stabilization of the exemplary method renders it
particularly suitable for mobile moving-picture communication
(mobile full-motion video) devices. Movements caused by the
mobile use of a full-motion video device should be reduced or
eliminated to the greatest possible extent.

One aspect of the exemplary method is to derive (deduce) the
camera movement from the relative displacement of consecutive
images, and to extract the subregion, for example, corrected
first image 16, from an input image, for example, first input
image 13, the subregion compensating for the camera movement,
based on the ascertained displacement 15, in particular of
corrected first image 16, with respect to uncorrected first
image 14.

In the exemplary method, a plurality of image regions 6, 7, 8 are made available for determining displacement 15. The image regions can be clearly (uniquely) determined inside the image, using their positions and their dimensions. By advantageously selecting the position and the dimensions of image regions 6, 7, 8, an image movement that is mainly generated by a camera movement can now be separated in a particularly simple manner, from an additional movement, which is superimposed on the image movement in subregions of the image to be corrected.

In addition, the probability of the image movement occurring at various positions of the images of an image sequence without the additional movement, is determined. The result of this is preferential portions (sections) inside the image, which can be used for separating the image movement from the additional movement. For example, the selection of image regions 6, 7, 8 represented in Figure 4 is especially advantageous for the special recording situation of a speaker who is in the center of the image.

The special characteristics of the recording situation are used as a priori knowledge in selecting and fixing image regions 6, 7, 8. In this recording situation, it can be assumed that the two first image regions 6, 7 are essentially in the background of the image and second image region 8 is essentially in the foreground.

This means that the two first image regions 6, 7 are mainly filled up with image data from the image background, and that second image region 8 is mainly filled up with image data from the image foreground. This allows the two first image regions 6, 7 to be advantageously prioritized, so that the determination of a displacement 15 of images in an image sequence may be derived from the determination of the regional displacement of the two first image regions 6, 7. Second image region 8 is only used for determining displacement 15 of images, when the use of regional displacements from the two

first image regions 6, 7 merely permits a regional
displacement, which is encumbered by a large lack of
reliability or an insufficiently large reliability factor.

5   In the specified example, this prioritization is synonymous to
       the image stabilization being carried out or performed using
       image-background information. However, this method does not
       exclusively relate to the differentiation and variable
       prioritization of background and foreground information, to
10   determine a displacement of images in an image sequence, but
       also relates, for example, to the use of criteria such as edge
       detection, absence of edge detection, or similar.

       In the specified example in QCIF format (Quarter Common
15   Intermediate Format), the two first image regions 6, 7
       typically extend 120 pixels in the vertical direction and 40
       pixels in the horizontal direction. In this image format,
       second image region 8 typically extends over 135 pixels in the
       vertical direction and 85 pixels in the horizontal direction.
20
       In the exemplary method for determining a displacement 15 of
       images in an image sequence, in particular, for image
       stabilization using a plurality of image regions 6, 7, 8 that
       each essentially cover the foreground or the background, the
25   most favorable combination of information may be ascertained
       in each case from the subregions, to minimize the influence of
       moving objects in the background. With the aid of a decision
       criterion, a moving object is detected in the image regions,
       which are, for the most part, covered by the background.
30
       If the two second image regions 6, 7 do not contain a moving
       object, and therefore, do not contain an additional movement
       by the moving object, which is superimposed on the image
       movement and is especially caused by a camera movement, then
35   the displacement to be calculated is determined from the mean
       of the calculated regional displacements of the two first
       image regions 6, 7. If one first image region 6, 7 contains a

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moving object, then displacement 15 to be determined is ascertained from the other image region not having a moving object. If both first image regions 6, 7 contain a moving object, then the information from second image region 8, the

5   foreground subregion, is used for determining the movement.

To determine the regional displacement of an image region 6, 7, 8, two alternative methods may be used, depending on whether or not block-displacement information from a

10   block-based encoding method, for example, from a block-based transmission mode (method) for reducing bandwidth, is accessible in a relatively simple way.

If block-displacement information is not easily accessible

15   (readily available), then a block-matching method, by which an additional movement, that is, a local movement inside one of the two first image regions 6, 7, can be detected, is used for determining the regional displacement. A local movement, for example, an appearing object, occurring in an image region 6,

20   7, 8 can be detected by evaluating the displacement-correlation values from the block-matching method.

To this end, the ratio of the average value of the

25   displacement-correlation values to the maximum correlation value is compared to an adaptive threshold-value function. To determine the mean of the displacement-correlation values, the sum of all of the determined correlation values is calculated and subsequently divided by the number of correlation values.

30   The maximum displacement-correlation value is assumed for a particular displacement. The regional displacement corresponding to the maximum displacement-correlation value is assumed to be the regional displacement. The correlation quotient corresponds to the maximum displacement-correlation

35   value divided by the mean of the displacement-correlation values, and is therefore normalized.

An additional movement, that is, a local movement inside the
image region, is then detected when the correlation quotient
is less than the value of an adaptive threshold-value
function. The adapted threshold-value function is a function

5   of the length of a displacement vector, which indicates a
regional displacement. To detect an additional movement or a
local movement in one of the two first image regions 6, 7, the
correlation quotient of the first region 6, 7 in consideration
may be compared to the value of the adaptive threshold-value

10   function, the value of the adaptive threshold-value function
resulting from the vector length of displacement 15 for the
other of the two first image regions 6, 7. In this context,
the threshold-value function may be defined as follows:

-       for any arbitrary length of the regional-displacement

15   vector, that is, for any arbitrary displacement, which is
less than a preselected, first threshold value, the value
of a preselected, second threshold value is assumed by
the threshold-value function;

-       for any arbitrary length of the regional-displacement

20   vector, which is greater than the preselected, first
threshold value, the value of the preselected, second
threshold value minus a product is assumed by the
threshold value function, the product including a
preselected slope parameter and a difference as factors,

25   and the difference being formed from the arbitrary
regional displacement and the preselected first threshold
value.

The second exemplary method for determining the displacement

30   of images in an image sequence is based on the use of
block-displacement information from a block-based encoding
method. As an alternative to calculating displacement, using a
block-matching method for an image region 6, 7, 8, the
displacement vectors of small blocks, for example, of size 8x8

35   or 16x16 can also be used for determining the regional
displacement of image regions 6, 7, 8, and therefore,
information from an encoding method can be directly used to

reduce the computational time.

This approach may be particularly of interest if, for example, hardware support allows the block-displacement vectors to be

5 obtained without additional expenditure, or with only a small amount of additional expenditure. A local movement inside an image region 6, 7, 8, in particular, inside one of the two first image regions 6, 7, can be detected in an especially simple manner, when displacement vectors of small blocks of

10 the image are, for example, known from an encoding method.

In this context, all of the displacement vectors for blocks lying within one of image regions 6, 7, 8 are initially assigned to the corresponding image region 6, 7, 8. Separate

15 frequency distributions or histograms are generated for the horizontal and vertical components of each of the assigned displacement vectors. The result for each image region 6, 7, 8 is a first frequency distribution for the horizontal component and a second frequency distribution for the vertical component

20 of the displacement vectors of the image blocks.

An additional movement or a local movement is detected by analyzing the frequency distributions assigned to the one image region. A local movement is detected, if the difference

25 of the positions between the principal maximum and the greatest secondary maximum of one of the two assigned frequency distributions exceeds a certain threshold value, and the magnitude of the principal maxima falls below a threshold value.

30

The determination of a local or additional movement inside an image region means that the regional displacement could not be calculated with sufficient reliability. Consequently, the calculation of the reliability factor of the

35 regional-displacement determination yields a negative result with regard to the regional-displacement determination.

The exemplary method for determining the regional
displacement, including its horizontal and vertical
components, and for calculating the reliability of the
regional-displacement determination, is described as follows:

5   -   to calculate the horizontal component of the regional
            displacement, a first frequency distribution is generated
            for the frequencies of different values of the horizontal
            components of the block-displacement information, the
            horizontal component of the regional displacement

10   corresponding to the value of the horizontal component of
            the block-displacement information, at which the first
            frequency distribution assumes its principal maximum;
       -    to calculate the vertical component of the regional
            displacement, a second frequency distribution is

15   generated for the frequencies of different values of the
            vertical components of the block-displacement
            information, the vertical component of the regional
            displacement corresponding to the value of the vertical
            component of the block-displacement information, at which

20   the second frequency distribution assumes its principal
            maximum;
       -    the reliability of the regional-displacement
            determination is considered to be sufficient, when all of
            the following conditions are fulfilled:

25   -   the absolute value of the difference in the position
                 of the values of the horizontal component of the
                 block-displacement information, which correspond to
                 the principal maximum and the secondary maximum of
                 the first frequency distribution, is less than a

30   preselected, first difference threshold;
            -    the absolute value of the difference in the position
                 of the values of the vertical component of the
                 block-displacement information, which correspond to
                 the principal maximum and the secondary maximum of

35   the second frequency distribution, is less than a
                 preselected, second difference threshold;
            -    the principal maximum of the first frequency

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distribution is greater than a first frequency
threshold; and

- the principal maximum of the second frequency
distribution is greater than a second frequency
5 threshold;

As an alternative to the block-matching method for an image
region 6, 7, 8 in question, block-displacement vectors of a
block-oriented image encoding method can therefore be used to
10 determine the displacement of images in an image sequence, to
reduce the computational time. For the block-matching method,
a criterion was specified which is suited for detecting local
movements inside relevant image region 6, 7, 8, and is
synonymous to the reliability of the regional-displacement
15 determination not being sufficient. A criterion for detecting
local movements inside relevant image regions 6, 7, 8 was
likewise specified for the displacement-estimation method
using block-displacement vectors.

ABSTRACT OF THE DISCLOSURE

A device and a method for determining a displacement of images
in an image sequence, which are specially used to compensate
for a camera movement. A plurality of image regions of the
5   images is available for determining the displacement, each
image region being provided at a preselected position of the
images, each image region having preselected dimensions, in
particular, a predetermined number of pixels in various
directions of the image, and an image movement mainly caused
10   by a camera movement being separated from an additional
movement that is superimposed on the image movement in a
subregion of the image to be corrected, by calculating the
probability of the movement occurring without the additional
movement is calculated at different positions of an image,
15   specifying and fixing for each image region, the position and
the dimensions as a function of the probability of the image
movement occurring inside the one image region without the
additional movement, and preferentially using at least one
image region out of the plurality of image regions for
20   determining the displacement.

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[10191/1974]

METHOD AND DEVICE FOR DETERMINING A
DISPLACEMENT OF IMAGES IN AN IMAGE SEQUENCE

[Background Information

]FIELD OF THE INVENTION

The present invention [starts out from]relates to a device and
method for determining the displacement of images in an image

5   sequence[according to the species defined in the main claim,
and from a device for determining the displacement of images
in an image sequence according to the species defined in the
other independent Claim 13.]_

10   BACKGROUND INFORMATION
An image-stabilization system, which is supposed to
substantially stabilize an image while recording with a
camcorder in one's hand, is [known from]discussed in the
article of H. Rindtorff, "Bildstabilisation in

15   Consumer-Camcordern, Funktion und Wirkungsweise" ("Image
Stabilization in Consumer Camcorders - Function and Mode of
Operation") Fernseh- und Kinotechnik (Television and Cinema
Technology), 49th year, no. ½, 1995.[ ]

20   In this context, and as characterized, the image is split up
into four sectors, in which movement vectors describing the
displacement of the image are determined. A total movement
vector, which ideally represents the displacement of the
camera, is determined from the movement vectors of the

25   individual sectors.

[Summary of the Invention

]SUMMARY OF THE INVENTION
In contrast, it is believed that the exemplary method of the

30   present invention[, possessing the features of the main

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claim,] has the advantage that image regions, which are
specially [utilized]used in the sections of an image[in
order] to determine the displacement of the images, are
distinguished by as high probability as possible, of the image
5   movement occurring without the additional movement. [By]In
this [means,]way, it is believed that the displacement of
images of an image sequence [is]may be determined in a
particularly reliable manner. In addition, it is believed that
this is conducive to [the]reliabl[e determination of]y
10   determining the displacement of images in an image sequence,
when the position and the dimensions of the image regions are
fixed. [T]

It is believed that this may especially allow[s] the
15   displacement to be reliably determined for a special scenario
of moving picture communication (full-motion video), using
relatively little processing time. A first image region, which
[is]may be preferentially [utilized]used from the plurality of
image regions to determine the displacement, may be used alone
20   for determining the displacement, by[means of] selecting its
position and its dimensions inside the images, so that other
image regions do not have to be considered, and thus, the
processing time for determining the displacement of images is
decreased.
25

[Advantageous further refinements and improvements of the
method indicated in the main claim are rendered possible by
measures specified in the dependent claims.

30   It is particularly]It is believed that it may be advantageous
that a first image of the image sequence is corrected by
determining the displacement, either from image data of the
first image and image data of a second image of the image
sequence that [preferably]may precede[s] the first image

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directly, or from image data of the first image and image data
of a second input image of the image sequence that
[preferably]may precede[s] the first image directly[; a]. A
regional displacement of an image region being [utilized]used

5   as a displacement, and the regional displacement of an image
region of the plurality of the image regions either being
determined from the image data of the first image and the
second image inside the one image region, or from the image
data of the first image and the second input image inside the

10   one image region. In this manner, only the image data of the
first and the second images inside the image region, which is
used for determining the displacement of the image, are needed
for processing, which means that the processing time [is]may
be reduced.

15
In addition, it is believed that it may be advantageous that
the position and the dimensions of the at least one first
image region are selected [in such a manner,]so that the at
least one first image region of the images to be corrected is

20   mainly filled in by the image background. Since[, as a rule,]
the image background[,] may rarely exhibits additional
movements from one image to another image, between which the
displacement should be determined, in which case the
additional movements are superimposed on the image movement

25   that is especially caused by the unintentional movement of a
camera, a first image region of the images to be corrected
[is]may be advantageously used for determining the
displacement, when it is filled in by the image background.

30   Furthermore, it is believed that it may be advantageous that
the position and the dimensions of at least one second image
region are selected in such a manner, that the at least one
second image region of the images to be corrected is mainly
filled in by the image foreground. This may allow[s] the

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displacement of images of an image sequence to be determined
in an especially simple manner, and with high accuracy, when,
[e.g.]for example, the image background is subjected to a
sharp, additional movement, which is superimposed on the image
5   movement that may be caused by the unintentional camera
movement.

[In order t]To determine the displacement, it is also believed
to be advantageous [that the]to use at least one first image
10   region and/or[the] at least one second image region[is used]
as a function of a margin of reliability (reliability factor),
for determining the regional displacement. This allows the
determination of the region displacement to be checked,
because a measure for the reliability of the
15   regional-displacement determination is available inside the
exemplary method. Therefore, the determination of a
reliability factor for the regional-displacement determination
is primarily used to simply and reliably separate the image
movement from the additional movement superimposed on it.
20

Furthermore, it is believed that it may be advantageous that
two first image regions and an individual second image region
are available for image correction, the displacement being
determined in one of the following three ways, in the order of
25   descending priority:

-       from the mean of the regional displacements of the two
        first image regions, when the reliability factor of the
        regional-displacement determination of the two first
30   image sequences is considered to be sufficient;
-       from the regional displacement of one of the two first
        image regions, in which the reliability of the
        regional-displacement determination is considered to be
        sufficient;

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- from the regional displacement of the second image region.

[T]It is believed that this may allow[s] different image
5   regions of different priority to be used for determining the
displacement of images in an image sequence. In particular,
[it is possible to preferentially utilize]image regions,
which are mainly filled in by the image background, may be
preferentially used for determining the displacement of
10   images[; t]. The use of the mean of the regional
displacements of the two first image regions resulting in a
reliable determination of the displacement.[ ]

The second priority for determining the displacement, using
15   the regional displacement calculated from the two first image
regions, is especially selected[in order] to minimize the
influence of objects moving in the background, since an object
moving into one of the two first image regions leads to the
regional displacement of the other of the two image regions
20   being used for determining the displacement of images in an
image sequence.[ ]

On the third level of priority, the displacement of images
from the regional displacement of the second image region,
25   especially from the regional displacement of an image region
that is mainly filled in by the image foreground, is used.

In addition, it is believed that it may be advantageous that
the exemplary method is used for a head-shoulder recording
30   situation, the two first image regions being selected to be in
a lateral image region, to the left and right of, and
[preferably]which may be symmetrical to, the vertical center
line of a predetermined rectangular image, the distance of the
two first image regions from the bottom image margin being

5

selected to be greater than the distance of the two first
image regions from the top image margin, the second image
region being selected to be near the center of the image,
[preferably]which may be symmetric to the vertical center line

5   of the rectangular image, and the distance of the second image
region from the top image margin [being preferably]may be
selected to be greater than the distance of the second image
region from the bottom image margin.[ ]

10   In the case of a head-shoulder recording situation, such a
choice of image regions particularly allows the information
from the image regions to be sensibly used for determining the
regional displacements, and sensibly used to determine the
displacement of images in an image sequence, by prioritizing

15   the [utilization]use of regional displacements.

In addition, it is believed that it may be advantageous that,
for two image regions, [preferably]which may be the two first
image regions, the regional displacement and the reliability

20   of the regional-displacement determination are determined by
[a]an exemplary method having the following steps:
-    the regional displacement and a correlation quotient are
    calculated for each of the two image regions;
-    a threshold value function is determined as a function of

25   each ascertained regional displacement of the two image
    regions;
-    each correlation quotient of one of the two image regions
    is compared to the value, which results from a threshold
    value function for the regional displacement of the other

30   of the two image regions;
-    the reliability of the regional-displacement
    determination for each of the two image regions is viewed
    as being sufficient, when the correlation quotient
    corresponding to the one image region is greater than the

value of the threshold-value function to be compared to
the correlation quotient.

In this manner, the reliability factors for the regional
5   displacement of the two first image regions are not determined
independently of each other, but rather the ascertained
regional displacement of one of the two first image regions
determines the value, which the threshold-value function
assumes, and to which the regional displacement of the other
10   of the two first image regions is compared. Therefore, the
regional displacement of one image region and the reliability
factor of the regional displacement are not determined
independently of movements, especially regional displacements,
in other parts of an image.
15

Furthermore, it is <u>believed that it may be</u> advantageous that
the correlation quotient of one of the two image regions is
determined according to [a]<u>an exemplary</u> method having the
following steps:
20   -   using a block-matching method, displacement-correlation
values are determined for several possible regional
displacements;
-     the regional displacement, for which the
displacement-correlation values are maximized, is
25   regarded as the regional displacement of the image
region;
-     the correlation quotient is formed by dividing the
maximum displacement-correlation value by the average
value of the calculated displacement-correlation values.
30

In this manner, the regional displacement is first of all
determined using the entire image region, since the
displacement-correlation values are calculated by forming the
sum over (of) all the image points of the image region in

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consideration. Secondly, the correlation quotient is normalized, since the maximum displacement-correlation value, from which the regional displacement results, is divided by the mean of the calculated displacement-correlation values.

5

In addition, it is <u>believed that it may be </u>advantageous that, for each arbitrary regional displacement less than a preselected first threshold value, the value of a preselected second threshold value is assumed by the threshold-value

10   function, and that, for each arbitrary regional displacement greater than the preselected first threshold value, the value of the preselected second threshold value minus a product is assumed by the threshold-value function[; t]<u>. The</u> product including a preselected slope parameter and a difference as

15   factors, and the difference being formed from the arbitrary regional displacement and the preselected first threshold value.[The]

<u>It is believed that an</u> advantage of this [is]<u>may be</u> that, for

20   larger, ascertained regional displacements of an image region, the regional displacement is allowed a sufficient margin of reliability, even when the correlation coefficient is smaller, which, in the case of a small, ascertained regional displacement, would indicate a correlation that is not as

25   good. Due to the dependence of the two first image regions in the calculation of the reliability factor for the determination of the regional displacement, the result of the structure of the threshold-value function is that, in response to a relatively large regional displacement of one of the two

30   first image regions, the required reliability of the regional-displacement determination, <u>that i</u>[.e.]<u>s,</u> the required magnitude of the correlation coefficient, [are]<u>may</u> not<u> be</u> as high.

In [a further, specific embodiment of the]another exemplary method for determining a displacement of images in an image sequence,[it is advantageous that] block-displacement information from a block-based encoding method is used for
5   determining the regional displacement[; t]. The block-displacement information, [preferably]which may be displacement vectors, of blocks lying inside the specific image region being considered for each of the image regions. [T]It is believed that this should result[s] in an especially
10   simple and cost-effective implementation of the exemplary method according to the present invention, especially when, [e.g.]for example, block-displacement information, in particular block-displacement vectors, of small image blocks can be obtained without additional expenditure, or with only a
15   small amount of additional expenditure.

In addition, [it is particularly advantageous for the second specific embodiment of the]an exemplary method according to the present invention[, that a method having] implements the
20   following steps[is implemented] for each of the image regions,[in order] to determine the regional displacement that has a horizontal and vertical component, and[in order] to calculate the reliability factor of the regional-displacement determination.
25   -   [In order t]To calculate the horizontal component of the regional displacement, a first frequency distribution is generated for the frequencies of different values of the horizontal components of the block-displacement information, the horizontal component of the regional
30   displacement corresponding to the value of the horizontal component of the block-displacement information, at which the first frequency distribution assumes its principal (global, absolute) maximum;
     -     [in order]to calculate the vertical component of the

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regional displacement, a second frequency distribution is generated for the frequencies of different values of the vertical components of the block-displacement information, the vertical component of the regional

5 displacement corresponding to the value of the vertical component of the block-displacement information, at which the second frequency distribution assumes its principal maximum;

- the reliability of the regional-displacement

10 determination is considered to be sufficient, when all of the following conditions are fulfilled;

- the absolute value of the difference in the position of the values of the horizontal component of the block-displacement information, which correspond to

15 the principal maximum and the secondary (local, relative) maximum of the first frequency distribution, is less than a preselected, first difference threshold;

- the absolute value of the difference in the position

20 of the values of the vertical component of the block-displacement information, which correspond to the principal maximum and the secondary maximum of the second frequency distribution, is less than a preselected, second difference threshold;

25 - the principal maximum of the first frequency distribution is greater than a first frequency threshold; and

- the principal maximum of the second frequency distribution is greater than a second frequency

30 threshold.

[Using simple means, in particular, b]By considering the frequencies of the occurring, horizontal and vertical components of the already present block-displacement

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information, [it is thereby possible to, first of
all]firstly,[determine] the regional displacement of an image
region may be determined, and secondly,[to calculate] the
reliability factor of the regional-displacement determination

5 may be calculated.

The exemplary device of the present invention, which is for
determining a displacement of images in an image sequence,
[and possesses the features of the other independent Claim

10 13,]is believed to ha[s]ve the advantage that the displacement
can especially be determined in a quicker and simpler manner
by implementing the exemplary method steps of the exemplary
method according to the present invention, in a microchip or
on a printed circuit board, which should result[s] in the

15 exemplary method of the present invention being carried out in
a quicker and more cost-effective manner.

[Brief Description of the Drawing

20 An exemplary embodiment of the present invention is
represented in the drawing and explained in detail in the
following description.

The figures show:

25

Figure 1]BRIEF DESCRIPTION OF THE DRAWINGS
Figure 1 shows a block diagram of the exemplary device
according to the present invention[;].

30 Figure 2 [   ]shows the principal of image stabilization, by
determining a displacement of images in an
image sequence[;].

Figure 3 [   ]shows a flowchart for image stabilization[;

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and]_.

Figure 4 [   ]shows an example of selecting image regions
inside an image, [in order]to implement the
exemplary method according to the present
invention.

5

[Description of the Exemplary Embodiment
]DETAILED DESCRIPTION

10   Figure 1 shows a block diagram of the_exemplary device
according to the present invention, for determining a
displacement of images in an image sequence. The exemplary
device[according to the present invention] includes an input
10, an output 20, a displacement-detection circuit 100, and a

15   magnification circuit 200. Displacement-detection circuit 100
includes a regional-displacement detector 110, an
image-storage device (display store) 120, and a microcomputer
130. In addition, displacement-detection circuit 100 includes
an input, which is not shown and is connected to input 10 of

20   the exemplary_device according to the present invention, to
regional-displacement detector 110, and to image-storage
device 120.

In addition, displacement-detection circuit 100 includes an

25   output, which is not shown and is connected to microcomputer
130[; r]._ Regional-displacement detector 110 is_also[being]
connected to microcomputer 130. Magnification circuit 200
includes two inputs not shown and an output, which is
connected to output 20 of the_exemplary device. The two inputs

30   of magnification circuit 200 are each connected to a
magnification processor 210, one of the two inputs of
magnification circuit 200 being connected to input 10 of the
exemplary device, and the other of the two inputs of
magnification circuit 200 being connected to the output of

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displacement-detection circuit 100.

[A]Figure 2 shows an example of image stabilization, [e.g.]for example, compensating for camera movements[, is represented in

5   Figure 2]. In this context, a first input image 13 is corrected to form a first output image 23, use being made of image information regarding a second input image 11, which [preferably]may precede[s] the first input image in time.

10   Second input image 11 includes an image detail, which is enlarged by magnification to form second output image 21. In this context, second input image 11 is completely recorded by the camera, but a user of the exemplary device[according to the present invention] may only see the image detail in

15   magnified form, as second output image 21. In this case, the image detail is referred to as second image 12, or also as corrected second image 12.

According to [a first specific embodiment of the]another

20   exemplary method of the present invention, corrected second image 12 is used to correct first input image 13. First input image 13 also includes an image detail, which is referred to here as uncorrected first image 14. A displacement 15 can be determined by comparing uncorrected first image 14 to second

25   image 12, that i[.e.]s, to corrected second image 12, so that uncorrected first image 14 can be converted into a corrected first image 16, using displacement 15. In particular, not all of the image data are utilized in comparing uncorrected first image 14 to second image 12, but rather, just the image data

30   from image regions (not shown) of first image 14 and second image 12.

According to [a second specific embodiment of the]another exemplary method of the present invention, second image 11 is

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used to correct first input image 13. Displacement 15 can be determined by comparing first input image 13 to second input image 11, so that uncorrected first image 14 can be converted into corrected first image 16, using displacement 15. In

5   particular, not all of the image data are utilized in comparing first input image 13 to second input image 11, but rather, just the image data from image regions (not shown) of first input image 13 and second input image 11.

10   Corrected first image 16 can now be shown to the user as a first output image 23, in accordance with both the first [specific embodiment]and[the] second [specific embodiment of the method according to the present invention]exemplary methods. Compared to the second output image, the displacement

15   of first input image 13 or corrected first image 16 can no longer be observed in first output image 23.

The [essential]method steps of the exemplary method according to the present invention are [represented]shown in Figure 3 by

20   a flow chart, using the correction of first input image 13 as an example. The regional displacements of image regions are determined in a first sequence step 30. In this connection, first input image 13 is compared to corrected second image 12, which especially precedes it in time, or the first input image

25   is compared to second input image 11, which especially precedes it in time. In sequence step 40, the displacement of first image 14 is subsequently determined in accordance with the exemplary method[of the present invention]. In third sequence step 50, uncorrected first image 14 is displaced by

30   displacement vector 15. The result of this operation is corrected first image 16. Subsequently, corrected first image 16 is enlarged in fourth sequence step 60, which results in first output image 23.

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[In order t]To correct a further input image[in accordance with the method of the present invention], the result of third sequence step 50 can be made available to first sequence step 30 by storing it, [preferably]which may be in image-storage device 120. The result of third sequence step 50 is corrected first image 16, which therefore appears in the place of corrected second image 12, and, in connection with the correction of the further input image, is used for determining regional displacements in first sequence step 30.

As an alternative, first input image 13 or uncorrected first image 14 can, together with calculated displacement 15, also be saved in image-storage device 120, [in order]to correct an additional input image.

[Represented in]Figure 4 [is]shows an example of a distribution of image details 6, 7, 8 inside first input image 14. In this context, two first image regions 6, 7 are selected to be symmetric to the vertical center line of given, rectangular first image 14, especially for using the exemplary method of the present invention in a head-shoulder recording situation. In this context, the distance of the two first image regions 6, 7 from the bottom image margin is greater than the distance of the two first image regions 6, 7 from the top image margin.

A second image region 8 is selected to be near the center of first image 14, [preferably]which may be symmetric to the vertical center line of the rectangular image, the distance of second image region 8 from the top image margin [being preferably]which may be selected to be greater than the distance of the second image region from the bottom image margin.

The exemplary method of the present invention for determining

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a displacement 15 of images in an image sequence [can preferably]may be used for image stabilization,[in order] to compensate for camera movements in consumer video cameras (camcorders). The digital, full-motion image stabilization of

5   the exemplary method renders it particularly suitable for mobile moving-picture communication (mobile full-motion video) devices. Movements caused by the mobile use of a full-motion video device should be reduced or eliminated to the greatest possible extent.[The basic principle]

10

One aspect of the exemplary method is to derive (deduce) the camera movement from the relative displacement of consecutive images, and to extract the subregion, [e.g.]for example, corrected first image 16, from an input image, [e.g.]for

15   example, first input image 13, the subregion compensating for the camera movement, based on the ascertained displacement 15, in particular of corrected first image 16, with respect to uncorrected first image 14.

20   In the exemplary method[according to the present invention], a plurality of image regions 6, 7, 8 are made available for determining displacement 15. The image regions can be clearly (uniquely) determined inside the image, using their positions and their dimensions. By advantageously selecting the position

25   and the dimensions of image regions 6, 7, 8, an image movement that is mainly generated by a camera movement can now be separated in a particularly simple manner, from an additional movement, which is superimposed on the image movement in subregions of the image to be corrected.[ ]

30

In addition, the probability of the image movement occurring at various positions of the images of an image sequence without the additional movement, is determined. The result of this is preferential portions (sections) inside the image,

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which can be used for separating the image movement from the
additional movement. For example, the selection of image
regions 6, 7, 8 represented in Figure 4 is especially
advantageous for the special recording situation of a speaker
5   who is in the center of the image.

The special characteristics of the recording situation are
used as a priori knowledge in selecting and fixing image
regions 6, 7, 8. In this recording situation, it can be
10   assumed that the two first image regions 6, 7 are essentially
in the background of the image and second image region 8 is
essentially in the foreground.

This means that the two first image regions 6, 7 are mainly
15   filled up with image data from the image background, and that
second image region 8 is mainly filled up with image data from
the image foreground. This allows the two first image regions
6, 7 to be advantageously prioritized, so that the
determination of a displacement 15 of images in an image
20   sequence [is preferably]may be derived from the determination
of the regional displacement of the two first image regions 6,
7. Second image region 8 is only used for determining
displacement 15 of images, when the use of regional
displacements from the two first image regions 6, 7 merely
25   permits a regional displacement, which is encumbered by a
large lack of reliability or an insufficiently large
reliability factor.

In the specified example, this prioritization is synonymous to
30   the image stabilization being [preferentially]carried out or
performed using image-background information. However, this
method does not exclusively relate to the differentiation and
variable prioritization of background and foreground
information,[in order] to determine a displacement of images

in an image sequence, but also relates, for example, to the use of criteria such as edge detection, absence of edge detection, or similar.

5   In the specified example in QCIF format (Quarter Common Intermediate Format), the two first image regions 6, 7 typically extend 120 pixels in the vertical direction and 40 pixels in the horizontal direction. In this image format, second image region 8 typically extends over 135 pixels in the
10   vertical direction and 85 pixels in the horizontal direction.

In the exemplary method for determining a displacement 15 of images in an image sequence, in particular, for image stabilization using a plurality of image regions 6, 7, 8 that
15   each essentially cover the foreground or the background, the most favorable combination of information [is] may be ascertained in each case from the subregions, [in order] to minimize the influence of moving objects in the background. With the aid of a decision criterion, a moving object is
20   detected in the image regions, which are, for the most part, covered by the background. [ ]

If the two second image regions 6, 7 do not contain a moving object, and therefore, do not contain an additional movement
25   by the moving object, which is superimposed on the image movement and is especially caused by a camera movement, then the displacement to be calculated is determined from the mean of the calculated regional displacements of the two first image regions 6, 7. If one first image region 6, 7 contains a
30   moving object, then displacement 15 to be determined is ascertained from the other image region not having a moving object. If both first image regions 6, 7 contain a moving object, then the information from second image region 8, the foreground subregion, is used for determining the movement. [

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In order to]

To determine the regional displacement of an image region 6,
7, 8, [the present invention uses]two alternative methods may
5   be used, depending on whether or not block-displacement
information from a block-based encoding method, [e.g.]for
example, from a block-based transmission mode (method) for
reducing bandwidth, is accessible [by]in a relatively simple
[means]way. [ ]
10

If block-displacement information is not easily accessible
(readily available), then a block-matching method, by which an
additional movement, that i[.e.]s, a local movement inside one
of the two first image regions 6, 7, can be detected, is used
15   for determining the regional displacement. A local movement,
[e.g.]for example, an appearing object, occurring in an image
region 6, 7, 8 can be detected by evaluating the
displacement-correlation values from the block-matching
method. [ ]
20

To this end, the ratio of the average value of the
displacement-correlation values to the maximum correlation
value is compared to an adaptive threshold-value function. [In
order t]To determine the mean of the displacement-correlation
25   values, the sum of all of the determined correlation values is
calculated and subsequently divided by the number of
correlation values. The maximum displacement-correlation value
is assumed for a particular displacement. The regional
displacement corresponding to the maximum
30   displacement-correlation value is assumed to be the regional
displacement. The correlation quotient corresponds to the
maximum displacement-correlation value divided by the mean of
the displacement-correlation values, and is therefore
normalized.

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An additional movement, that i[.e.]s, a local movement inside
the image region, is then detected when the correlation
quotient is less than the value of an adaptive threshold-value
function. The adapted threshold-value function is a function
5   of the length of a displacement vector, which indicates a
regional displacement. [In order t]To detect an additional
movement or a local movement in one of the two first image
regions 6, 7, the [present invention provides for the
]correlation quotient of the first region 6, 7 in
10   consideration [being]may be compared to the value of the
adaptive threshold-value function, the value of the adaptive
threshold-value function resulting from the vector length of
displacement 15 for the other of the two first image regions
6, 7. In this context, the threshold-value function [is]may be
15   defined as follows:

[

]-   for any arbitrary length of the regional-displacement
vector, that i[.e.]s, for any arbitrary displacement,
which is less than a preselected, first threshold value,
20   the value of a preselected, second threshold value is
assumed by the threshold-value function;

-     for any arbitrary length of the regional-displacement
vector, which is greater than the preselected, first
threshold value, the value of the preselected, second
25   threshold value minus a product is assumed by the
threshold value function, the product including a
preselected slope parameter and a difference as factors,
and the difference being formed from the arbitrary
regional displacement and the preselected first threshold
30   value.

The second exemplary method for determining the displacement
of images in an image sequence is based on the use of
block-displacement information from a block-based encoding

20

method. As an alternative to calculating displacement, using a
block-matching method for an image region 6, 7, 8, the
displacement vectors of small blocks, [e.g.]for example, of
size 8x8 or 16x16 can also be used for determining the
5   regional displacement of image regions 6, 7, 8, and therefore,
information from an encoding method can be directly used [in
order]to reduce the computational time.

This approach [is]may be particularly of interest if, for
10   example, hardware support allows the block-displacement
vectors to be obtained without additional expenditure, or with
only a small amount of additional expenditure. A local
movement inside an image region 6, 7, 8, in particular, inside
one of the two first image regions 6, 7, can be detected in an
15   especially simple manner, when displacement vectors of small
blocks of the image are, for example, known from an encoding
method.

In this context, all of the displacement vectors for blocks
20   lying within one of image regions 6, 7, 8 are initially
assigned to the corresponding image region 6, 7, 8. Separate
frequency distributions or histograms are generated for the
horizontal and vertical components of each of the assigned
displacement vectors. The result for each image region 6, 7, 8
25   is a first frequency distribution for the horizontal component
and a second frequency distribution for the vertical component
of the displacement vectors of the image blocks.

An additional movement or a local movement is detected by
30   analyzing the frequency distributions assigned to the one
image region. A local movement is detected, if the difference
of the positions between the principal maximum and the
greatest secondary maximum of one of the two assigned
frequency distributions exceeds a certain threshold value, and

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the magnitude of the principal maxima falls below a threshold value.

The determination of a local or additional movement inside an
5   image region means that the regional displacement could not be
calculated with sufficient reliability. Consequently, the
calculation of the reliability factor of the
regional-displacement determination yields a negative result
with regard to the regional-displacement determination.
10
The exemplary method for determining the regional
displacement, including its horizontal and vertical
components, and for calculating the reliability of the
regional-displacement determination, [can be]is described[in
15   a more detailed manner] as follows:
-        [in order]to calculate the horizontal component of the
         regional displacement, a first frequency distribution is
         generated for the frequencies of different values of the
         horizontal components of the block-displacement
20   information, the horizontal component of the regional
         displacement corresponding to the value of the horizontal
         component of the block-displacement information, at which
         the first frequency distribution assumes its principal
         maximum;
25   -   [in order]to calculate the vertical component of the
         regional displacement, a second frequency distribution is
         generated for the frequencies of different values of the
         vertical components of the block-displacement
         information, the vertical component of the regional
30   displacement corresponding to the value of the vertical
         component of the block-displacement information, at which
         the second frequency distribution assumes its principal
         maximum;
-        the reliability of the regional-displacement

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determination is considered to be sufficient, when all of the following conditions are fulfilled:

- the absolute value of the difference in the position of the values of the horizontal component of the block-displacement information, which correspond to the principal maximum and the secondary maximum of the first frequency distribution, is less than a preselected, first difference threshold;

- the absolute value of the difference in the position of the values of the vertical component of the block-displacement information, which correspond to the principal maximum and the secondary maximum of the second frequency distribution, is less than a preselected, second difference threshold;

- the principal maximum of the first frequency distribution is greater than a first frequency threshold; and

- the principal maximum of the second frequency distribution is greater than a second frequency threshold;

As an alternative to the block-matching method for an image region 6, 7, 8 in question, block-displacement vectors of a block-oriented image encoding method can therefore be used to determine the displacement of images in an image sequence, [in order]to reduce the computational time. For the block-matching method, a criterion was specified which is suited for detecting local movements inside relevant image region 6, 7, 8, and is synonymous to the reliability of the regional-displacement determination not being sufficient. A criterion for detecting local movements inside relevant image regions 6, 7, 8 was likewise specified for the displacement-estimation method using block-displacement vectors.

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[Abstract

Proposed is]

ABSTRACT OF THE DISCLOSURE

5   A device and a method for determining a displacement[(15) of images in an image sequence, and a device for determining a displacement (15)] of images in an image sequence, which are specially used to compensate for a camera movement. A plurality of image regions [(6, 7, 8)]of the images is

10   available for determining the displacement[(15)], each image region[(6, 7, 8)] being provided at a preselected position of the images, each image region[(6, 7, 8)] having preselected dimensions, in particular, a predetermined number of pixels in various directions of the image, and an image movement mainly

15   caused by a camera movement being separated from an additional movement that is superimposed on the image movement in a subregion of the image to be corrected, [using the following steps:

-]by calculating the probability of the movement occurring

20   without the additional movement is calculated at different positions of an image[;

-]_, specifying and fixing for each image region[(6, 7, 8,)]_, the position and the dimensions[are specified and fixed] as a function of the probability of the image movement occurring

25   inside the one image region [(6, 7, 8)]without the additional movement[;]_, and[

-] preferentially using at least one image region[(6, 7)] out of the plurality of image regions [(6, 7, 8) is preferentially used]for determining the displacement[(15)].

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[(Figure 4)]

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[10191/1974]

METHOD AND DEVICE FOR DETERMINING A
DISPLACEMENT OF IMAGES IN AN IMAGE SEQUENCE

Background Information

The present invention starts out from a method for determining
the displacement of images in an image sequence according to

5   the species defined in the main claim, and from a device for
determining the displacement of images in an image sequence
according to the species defined in the other independent
Claim 13. An image-stabilization system, which is supposed to
substantially stabilize an image while recording with a

10   camcorder in one's hand, is known from the article of H.
Rindtorff, "Bildstabilisation in Consumer-Camcordern, Funktion
und Wirkungsweise" ("Image Stabilization in Consumer
Camcorders - Function and Mode of Operation") Fernseh- und
Kinotechnik (Television and Cinema Technology), 49th year, no.

15   ½, 1995. In this context, the image is split up into four
sectors, in which movement vectors describing the displacement
of the image are determined. A total movement vector, which
ideally represents the displacement of the camera, is
determined from the movement vectors of the individual

20   sectors.

Summary of the Invention

In contrast, the method of the present invention, possessing

25   the features of the main claim, has the advantage that image
regions, which are specially utilized in the sections of an
image in order to determine the displacement of the images,
are distinguished by as high probability as possible, of the
image movement occurring without the additional movement. By

30   this means, the displacement of images of an image sequence is
determined in a particularly reliable manner. In addition, it
is conducive to the reliable determination of the displacement

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of images in an image sequence, when the position and the
dimensions of the image regions are fixed. This especially
allows the displacement to be reliably determined for a
special scenario of moving picture communication (full-motion

5   video), using relatively little processing time. A first image
region, which is preferentially utilized from the plurality of
image regions to determine the displacement, may be used alone
for determining the displacement, by means of selecting its
position and its dimensions inside the images, so that other

10   image regions do not have to be considered, and thus, the
processing time for determining the displacement of images is
decreased.

Advantageous further refinements and improvements of the

15   method indicated in the main claim are rendered possible by
measures specified in the dependent claims.

It is particularly advantageous that a first image of the
image sequence is corrected by determining the displacement,

20   either from image data of the first image and image data of a
second image of the image sequence that preferably precedes
the first image directly, or from image data of the first
image and image data of a second input image of the image
sequence that preferably precedes the first image directly; a

25   regional displacement of an image region being utilized as a
displacement, and the regional displacement of an image region
of the plurality of the image regions either being determined
from the image data of the first image and the second image
inside the one image region, or from the image data of the

30   first image and the second input image inside the one image
region. In this manner, only the image data of the first and
the second images inside the image region, which is used for
determining the displacement of the image, are needed for
processing, which means that the processing time is reduced.

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In addition, it is advantageous that the position and the
dimensions of the at least one first image region are selected

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in such a manner, that the at least one first image region of
the images to be corrected is mainly filled in by the image
background. Since, as a rule, the image background, rarely
exhibits additional movements from one image to another image,

5   between which the displacement should be determined, in which
case the additional movements are superimposed on the image
movement that is especially caused by the unintentional
movement of a camera, a first image region of the images to be
corrected is advantageously used for determining the

10   displacement, when it is filled in by the image background.

Furthermore, it is advantageous that the position and the
dimensions of at least one second image region are selected in
such a manner, that the at least one second image region of

15   the images to be corrected is mainly filled in by the image
foreground. This allows the displacement of images of an image
sequence to be determined in an especially simple manner, and
with high accuracy, when, e.g. the image background is
subjected to a sharp, additional movement, which is

20   superimposed on the image movement that may be caused by the
unintentional camera movement.

In order to determine the displacement, it is also
advantageous that the at least one first and/or the at least

25   one second image region is used as a function of a margin of
reliability (reliability factor), for determining the regional
displacement. This allows the determination of the region
displacement to be checked, because a measure for the
reliability of the regional-displacement determination is

30   available inside the method. Therefore, the determination of a
reliability factor for the regional-displacement determination
is primarily used to simply and reliably separate the image
movement from the additional movement superimposed on it.

35   Furthermore, it is advantageous that two first image regions
and an individual second image region are available for image
correction, the displacement being determined in one of the

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following three ways, in the order of descending priority:

5

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-       from the mean of the regional displacements of the two
        first image regions, when the reliability factor of the
        regional-displacement determination of the two first
        image sequences is considered to be sufficient;
-       from the regional displacement of one of the two first
        image regions, in which the reliability of the
        regional-displacement determination is considered to be
        sufficient;
-       from the regional displacement of the second image
        region.

This allows different image regions of different priority to
be used for determining the displacement of images in an image
sequence. In particular, it is possible to preferentially
utilize image regions, which are mainly filled in by the image
background, for determining the displacement of images; the
use of the mean of the regional displacements of the two first
image regions resulting in a reliable determination of the
displacement. The second priority for determining the
displacement, using the regional displacement calculated from
the two first image regions, is especially selected in order
to minimize the influence of objects moving in the background,
since an object moving into one of the two first image regions
leads to the regional displacement of the other of the two
image regions being used for determining the displacement of
images in an image sequence. On the third level of priority,
the displacement of images from the regional displacement of
the second image region, especially from the regional
displacement of an image region that is mainly filled in by
the image foreground, is used.

In addition, it is advantageous that the method is used for a
head-shoulder recording situation, the two first image regions
being selected to be in a lateral image region, to the left
and right of, and preferably symmetrical to, the vertical

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center line of a predetermined rectangular image, the distance
of the two first image regions from the bottom image margin
being selected to be greater than the distance of the two
first image regions from the top image margin, the second

5   image region being selected to be near the center of the
image, preferably symmetric to the vertical center line of the
rectangular image, and the distance of the second image region
from the top image margin being preferably selected to be
greater than the distance of the second image region from the

10   bottom image margin. In the case of a head-shoulder recording
situation, such a choice of image regions particularly allows
the information from the image regions to be sensibly used for
determining the regional displacements, and sensibly used to
determine the displacement of images in an image sequence, by

15   prioritizing the utilization of regional displacements.

In addition, it is advantageous that, for two image regions,
preferably the two first image regions, the regional
displacement and the reliability of the regional-displacement

20   determination are determined by a method having the following
steps:
-      the regional displacement and a correlation quotient are
       calculated for each of the two image regions;
-      a threshold value function is determined as a function of

25   each ascertained regional displacement of the two image
       regions;
-      each correlation quotient of one of the two image regions
       is compared to the value, which results from a threshold
       value function for the regional displacement of the other

30   of the two image regions;
-      the reliability of the regional-displacement
       determination for each of the two image regions is viewed
       as being sufficient, when the correlation quotient
       corresponding to the one image region is greater than the

35   value of the threshold-value function to be compared to
       the correlation quotient.

5

In this manner, the reliability factors for the regional displacement of the two first image regions are not determined independently of each other, but rather the ascertained regional displacement of one of the two first image regions

5   determines the value, which the threshold-value function assumes, and to which the regional displacement of the other of the two first image regions is compared. Therefore, the regional displacement of one image region and the reliability factor of the regional displacement are not determined

10   independently of movements, especially regional displacements, in other parts of an image.

Furthermore, it is advantageous that the correlation quotient of one of the two image regions is determined according to a

15   method having the following steps:
- using a block-matching method, displacement-correlation values are determined for several possible regional displacements;
- the regional displacement, for which the

20   displacement-correlation values are maximized, is regarded as the regional displacement of the image region;
- the correlation quotient is formed by dividing the maximum displacement-correlation value by the average

25   value of the calculated displacement-correlation values.

In this manner, the regional displacement is first of all determined using the entire image region, since the displacement-correlation values are calculated by forming the

30   sum over (of) all the image points of the image region in consideration. Secondly, the correlation quotient is normalized, since the maximum displacement-correlation value, from which the regional displacement results, is divided by the mean of the calculated displacement-correlation values.

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In addition, it is advantageous that, for each arbitrary regional displacement less than a preselected first threshold

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value, the value of a preselected second threshold value is
assumed by the threshold-value function, and that, for each
arbitrary regional displacement greater than the preselected
first threshold value, the value of the preselected second
5   threshold value minus a product is assumed by the
threshold-value function; the product including a preselected
slope parameter and a difference as factors, and the
difference being formed from the arbitrary regional
displacement and the preselected first threshold value. The
10   advantage of this is that, for larger, ascertained regional
displacements of an image region, the regional displacement is
allowed a sufficient margin of reliability, even when the
correlation coefficient is smaller, which, in the case of a
small, ascertained regional displacement, would indicate a
15   correlation that is not as good. Due to the dependence of the
two first image regions in the calculation of the reliability
factor for the determination of the regional displacement, the
result of the structure of the threshold-value function is
that, in response to a relatively large regional displacement
20   of one of the two first image regions, the required
reliability of the regional-displacement determination, i.e.
the required magnitude of the correlation coefficient, are not
as high.

25   In a further, specific embodiment of the method for
determining a displacement of images in an image sequence, it
is advantageous that block-displacement information from a
block-based encoding method is used for determining the
regional displacement; the block-displacement information,
30   preferably displacement vectors, of blocks lying inside the
specific image region being considered for each of the image
regions. This results in an especially simple and
cost-effective implementation of the method according to the
present invention, especially when, e.g. block-displacement
35   information, in particular block-displacement vectors, of
small image blocks can be obtained without additional
expenditure, or with only a small amount of additional

expenditure.

In addition, it is particularly advantageous for the second
specific embodiment of the method according to the present
invention, that a method having the following steps is
implemented for each of the image regions, in order to
determine the regional displacement that has a horizontal and
vertical component, and in order to calculate the reliability
factor of the regional-displacement determination.
- In order to calculate the horizontal component of the
  regional displacement, a first frequency distribution is
  generated for the frequencies of different values of the
  horizontal components of the block-displacement
  information, the horizontal component of the regional
  displacement corresponding to the value of the horizontal
  component of the block-displacement information, at which
  the first frequency distribution assumes its principal
  (global, absolute) maximum;
- in order to calculate the vertical component of the
  regional displacement, a second frequency distribution is
  generated for the frequencies of different values of the
  vertical components of the block-displacement
  information, the vertical component of the regional
  displacement corresponding to the value of the vertical
  component of the block-displacement information, at which
  the second frequency distribution assumes its principal
  maximum;
- the reliability of the regional-displacement
  determination is considered to be sufficient, when all of
  the following conditions are fulfilled;
  - the absolute value of the difference in the position
    of the values of the horizontal component of the
    block-displacement information, which correspond to
    the principal maximum and the secondary (local,
    relative) maximum of the first frequency
    distribution, is less than a preselected, first
    difference threshold;

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- the absolute value of the difference in the position
of the values of the vertical component of the
block-displacement information, which correspond to
the principal maximum and the secondary maximum of

5   the second frequency distribution, is less than a
preselected, second difference threshold;

- the principal maximum of the first frequency
distribution is greater than a first frequency
threshold; and

10   - the principal maximum of the second frequency
distribution is greater than a second frequency
threshold.

Using simple means, in particular, by considering the

15   frequencies of the occurring, horizontal and vertical
components of the already present block-displacement
information, it is thereby possible to, first of all,
determine the regional displacement of an image region, and
secondly, to calculate the reliability factor of the

20   regional-displacement determination.

The device of the present invention, which is for determining
a displacement of images in an image sequence, and possesses
the features of the other independent Claim 13, has the

25   advantage that the displacement can especially be determined
in a quicker and simpler manner by implementing the method
steps of the method according to the present invention, in a
microchip or on a printed circuit board, which results in the
method of the present invention being carried out in a quicker

30   and more cost-effective manner.

Brief Description of the Drawing

An exemplary embodiment of the present invention is

35   represented in the drawing and explained in detail in the
following description.

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The figures show:

Figure 1   a block diagram of the device according to the
           present invention;

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Figure 2   the principal of image stabilization, by determining
           a displacement of images in an image sequence;

Figure 3   a flowchart for image stabilization; and

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Figure 4   an example of selecting image regions inside an
           image, in order to implement the method according to
           the present invention.

15   Description of the Exemplary Embodiment

     Figure 1 shows a block diagram of the device according to the
     present invention, for determining a displacement of images in
     an image sequence. The device according to the present
20   invention includes an input 10, an output 20, a
     displacement-detection circuit 100, and a magnification
     circuit 200. Displacement-detection circuit 100 includes a
     regional-displacement detector 110, an image-storage device
     (display store) 120, and a microcomputer 130. In addition,
25   displacement-detection circuit 100 includes an input, which is
     not shown and is connected to input 10 of the device according
     to the present invention, to regional-displacement detector
     110, and to image-storage device 120. In addition,
     displacement-detection circuit 100 includes an output, which
30   is not shown and is connected to microcomputer 130;
     regional-displacement detector 110 also being connected to
     microcomputer 130. Magnification circuit 200 includes two
     inputs not shown and an output, which is connected to output
     20 of the device. The two inputs of magnification circuit 200
35   are each connected to a magnification processor 210, one of
     the two inputs of magnification circuit 200 being connected to
     input 10 of the device, and the other of the two inputs of

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magnification circuit 200 being connected to the output of displacement-detection circuit 100.

An example of image stabilization, e.g. compensating for
5   camera movements, is represented in Figure 2. In this context, a first input image 13 is corrected to form a first output image 23, use being made of image information regarding a second input image 11, which preferably precedes the first input image in time.
10

Second input image 11 includes an image detail, which is enlarged by magnification to form second output image 21. In this context, second input image 11 is completely recorded by the camera, but a user of the device according to the present
15   invention may only see the image detail in magnified form, as second output image 21. In this case, the image detail is referred to as second image 12, or also as corrected second image 12.

20   According to a first specific embodiment of the method of the present invention, corrected second image 12 is used to correct first input image 13. First input image 13 also includes an image detail, which is referred to here as uncorrected first image 14. A displacement 15 can be
25   determined by comparing uncorrected first image 14 to second image 12, i.e. to corrected second image 12, so that uncorrected first image 14 can be converted into a corrected first image 16, using displacement 15. In particular, not all of the image data are utilized in comparing uncorrected first
30   image 14 to second image 12, but rather, just the image data from image regions (not shown) of first image 14 and second image 12.

According to a second specific embodiment of the method of the
35   present invention, second image 11 is used to correct first input image 13. Displacement 15 can be determined by comparing first input image 13 to second input image 11, so that

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uncorrected first image 14 can be converted into corrected
first image 16, using displacement 15. In particular, not all
of the image data are utilized in comparing first input image
13 to second input image 11, but rather, just the image data
5   from image regions (not shown) of first input image 13 and
second input image 11.

Corrected first image 16 can now be shown to the user as a
first output image 23, in accordance with both the first
10   specific embodiment and the second specific embodiment of the
method according to the present invention. Compared to the
second output image, the displacement of first input image 13
or corrected first image 16 can no longer be observed in first
output image 23.
15

The essential method steps of the method according to the
present invention are represented in Figure 3 by a flow chart,
using the correction of first input image 13 as an example.
The regional displacements of image regions are determined in
20   a first sequence step 30. In this connection, first input
image 13 is compared to corrected second image 12, which
especially precedes it in time, or the first input image is
compared to second input image 11, which especially precedes
it in time. In sequence step 40, the displacement of first
25   image 14 is subsequently determined in accordance with the
method of the present invention. In third sequence step 50,
uncorrected first image 14 is displaced by displacement vector
15. The result of this operation is corrected first image 16.
Subsequently, corrected first image 16 is enlarged in fourth
30   sequence step 60, which results in first output image 23.

In order to correct a further input image in accordance with
the method of the present invention, the result of third
sequence step 50 can be made available to first sequence step
35   30 by storing it, preferably in image-storage device 120. The
result of third sequence step 50 is corrected first image 16,
which therefore appears in the place of corrected second image

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12, and, in connection with the correction of the further
input image, is used for determining regional displacements in
first sequence step 30.

5   As an alternative, first input image 13 or uncorrected first
image 14 can, together with calculated displacement 15, also
be saved in image-storage device 120, in order to correct an
additional input image.

10   Represented in Figure 4 is an example of a distribution of
image details 6, 7, 8 inside first input image 14. In this
context, two first image regions 6, 7 are selected to be
symmetric to the vertical center line of given, rectangular
first image 14, especially for using the method of the present
15   invention in a head-shoulder recording situation. In this
context, the distance of the two first image regions 6, 7 from
the bottom image margin is greater than the distance of the
two first image regions 6, 7 from the top image margin.
A second image region 8 is selected to be near the center of
20   first image 14, preferably symmetric to the vertical center
line of the rectangular image, the distance of second image
region 8 from the top image margin being preferably selected
to be greater than the distance of the second image region
from the bottom image margin.
25

The method of the present invention for determining a
displacement 15 of images in an image sequence can preferably
be used for image stabilization, in order to compensate for
camera movements in consumer video cameras (camcorders). The
30   digital, full-motion image stabilization of the method renders
it particularly suitable for mobile moving-picture
communication (mobile full-motion video) devices. Movements
caused by the mobile use of a full-motion video device should
be reduced or eliminated to the greatest possible extent. The
35   basic principle of the method is to derive (deduce) the camera
movement from the relative displacement of consecutive images,
and to extract the subregion, e.g. corrected first image 16,

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from an input image, e.g. first input image 13, the subregion
compensating for the camera movement, based on the ascertained
displacement 15, in particular of corrected first image 16,
with respect to uncorrected first image 14.

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In the method according to the present invention, a plurality
of image regions 6, 7, 8 are made available for determining
displacement 15. The image regions can be clearly (uniquely)
determined inside the image, using their positions and their
10 dimensions. By advantageously selecting the position and the
dimensions of image regions 6, 7, 8, an image movement that is
mainly generated by a camera movement can now be separated in
a particularly simple manner, from an additional movement,
which is superimposed on the image movement in subregions of
15 the image to be corrected. In addition, the probability of the
image movement occurring at various positions of the images of
an image sequence without the additional movement, is
determined. The result of this is preferential portions
(sections) inside the image, which can be used for separating
20 the image movement from the additional movement. For example,
the selection of image regions 6, 7, 8 represented in Figure 4
is especially advantageous for the special recording situation
of a speaker who is in the center of the image. The special
characteristics of the recording situation are used as a
25 priori knowledge in selecting and fixing image regions 6, 7,
8. In this recording situation, it can be assumed that the two
first image regions 6, 7 are essentially in the background of
the image and second image region 8 is essentially in the
foreground. This means that the two first image regions 6, 7
30 are mainly filled up with image data from the image
background, and that second image region 8 is mainly filled up
with image data from the image foreground. This allows the two
first image regions 6, 7 to be advantageously prioritized, so
that the determination of a displacement 15 of images in an
35 image sequence is preferably derived from the determination of
the regional displacement of the two first image regions 6, 7.
Second image region 8 is only used for determining

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displacement 15 of images, when the use of regional
displacements from the two first image regions 6, 7 merely
permits a regional displacement, which is encumbered by a
large lack of reliability or an insufficiently large

5   reliability factor. In the specified example, this
prioritization is synonymous to the image stabilization being
preferentially carried out using image-background information.
However, this method does not exclusively relate to the
differentiation and variable prioritization of background and

10   foreground information, in order to determine a displacement
of images in an image sequence, but also relates, for example,
to the use of criteria such as edge detection, absence of edge
detection, or similar.

15   In the specified example in QCIF format (Quarter Common
Intermediate Format), the two first image regions 6, 7
typically extend 120 pixels in the vertical direction and 40
pixels in the horizontal direction. In this image format,
second image region 8 typically extends over 135 pixels in the

20   vertical direction and 85 pixels in the horizontal direction.

In the method for determining a displacement 15 of images in
an image sequence, in particular, for image stabilization
using a plurality of image regions 6, 7, 8 that each

25   essentially cover the foreground or the background, the most
favorable combination of information is ascertained in each
case from the subregions, in order to minimize the influence
of moving objects in the background. With the aid of a
decision criterion, a moving object is detected in the image

30   regions, which are, for the most part, covered by the
background. If the two second image regions 6, 7 do not
contain a moving object, and therefore, do not contain an
additional movement by the moving object, which is
superimposed on the image movement and is especially caused by

35   a camera movement, then the displacement to be calculated is
determined from the mean of the calculated regional
displacements of the two first image regions 6, 7. If one

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first image region 6, 7 contains a moving object, then
displacement 15 to be determined is ascertained from the other
image region not having a moving object. If both first image
regions 6, 7 contain a moving object, then the information
5   from second image region 8, the foreground subregion, is used
for determining the movement. In order to determine the
regional displacement of an image region 6, 7, 8, the present
invention uses two alternative methods, depending on whether
or not block-displacement information from a block-based
10   encoding method, e.g. from a block-based transmission mode
(method) for reducing bandwidth, is accessible by simple
means. If block-displacement information is not easily
accessible (readily available), then a block-matching method,
by which an additional movement, i.e. a local movement inside
15   one of the two first image regions 6, 7, can be detected, is
used for determining the regional displacement. A local
movement, e.g. an appearing object, occurring in an image
region 6, 7, 8 can be detected by evaluating the
displacement-correlation values from the block-matching
20   method. To this end, the ratio of the average value of the
displacement-correlation values to the maximum correlation
value is compared to an adaptive threshold-value function. In
order to determine the mean of the displacement-correlation
values, the sum of all of the determined correlation values is
25   calculated and subsequently divided by the number of
correlation values. The maximum displacement-correlation value
is assumed for a particular displacement. The regional
displacement corresponding to the maximum
displacement-correlation value is assumed to be the regional
30   displacement. The correlation quotient corresponds to the
maximum displacement-correlation value divided by the mean of
the displacement-correlation values, and is therefore
normalized.

35   An additional movement, i.e. a local movement inside the image
region, is then detected when the correlation quotient is less
than the value of an adaptive threshold-value function. The

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adapted threshold-value function is a function of the length
of a displacement vector, which indicates a regional
displacement. In order to detect an additional movement or a
local movement in one of the two first image regions 6, 7, the
5   present invention provides for the correlation quotient of the
first region 6, 7 in consideration being compared to the value
of the adaptive threshold-value function, the value of the
adaptive threshold-value function resulting from the vector
length of displacement 15 for the other of the two first image
10   regions 6, 7. In this context, the threshold-value function is
defined as follows:

-      for any arbitrary length of the regional-displacement
       vector, i.e. for any arbitrary displacement, which is
15   less than a preselected, first threshold value, the value
       of a preselected, second threshold value is assumed by
       the threshold-value function;
-      for any arbitrary length of. the regional-displacement
       vector, which is greater than the preselected, first
20   threshold value, the value of the preselected, second
       threshold value minus a product is assumed by the
       threshold value function, the product including a
       preselected slope parameter and a difference as factors,
       and the difference being formed from the arbitrary
25   regional displacement and the preselected first threshold
       value.

The second method for determining the displacement of images
in an image sequence is based on the use of block-displacement
30   information from a block-based encoding method. As an
alternative to calculating displacement, using a
block-matching method for an image region 6, 7, 8, the
displacement vectors of small blocks, e.g. of size 8x8 or
16x16 can also be used for determining the regional
35   displacement of image regions 6, 7, 8, and therefore,
information from an encoding method can be directly used in
order to reduce the computational time. This approach is

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particularly of interest if, for example, hardware support
allows the block-displacement vectors to be obtained without
additional expenditure, or with only a small amount of
additional expenditure. A local movement inside an image

5   region 6, 7, 8, in particular, inside one of the two first
image regions 6, 7, can be detected in an especially simple
manner, when displacement vectors of small blocks of the image
are, for example, known from an encoding method. In this
context, all of the displacement vectors for blocks lying

10   within one of image regions 6, 7, 8 are initially assigned to
the corresponding image region 6, 7, 8. Separate frequency
distributions or histograms are generated for the horizontal
and vertical components of each of the assigned displacement
vectors. The result for each image region 6, 7, 8 is a first

15   frequency distribution for the horizontal component and a
second frequency distribution for the vertical component of
the displacement vectors of the image blocks. An additional
movement or a local movement is detected by analyzing the
frequency distributions assigned to the one image region. A

20   local movement is detected, if the difference of the positions
between the principal maximum and the greatest secondary
maximum of one of the two assigned frequency distributions
exceeds a certain threshold value, and the magnitude of the
principal maxima falls below a threshold value.

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The determination of a local or additional movement inside an
image region means that the regional displacement could not be
calculated with sufficient reliability. Consequently, the
calculation of the reliability factor of the

30   regional-displacement determination yields a negative result
with regard to the regional-displacement determination.

The method for determining the regional displacement,
including its horizontal and vertical components, and for

35   calculating the reliability of the regional-displacement
determination, can be described in a more detailed manner as
follows:

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- in order to calculate the horizontal component of the regional displacement, a first frequency distribution is generated for the frequencies of different values of the horizontal components of the block-displacement

5 information, the horizontal component of the regional displacement corresponding to the value of the horizontal component of the block-displacement information, at which the first frequency distribution assumes its principal maximum;

10 - in order to calculate the vertical component of the regional displacement, a second frequency distribution is generated for the frequencies of different values of the vertical components of the block-displacement information, the vertical component of the regional

15 displacement corresponding to the value of the vertical component of the block-displacement information, at which the second frequency distribution assumes its principal maximum;

- the reliability of the regional-displacement

20 determination is considered to be sufficient, when all of the following conditions are fulfilled:
    - the absolute value of the difference in the position of the values of the horizontal component of the block-displacement information, which correspond to

25 the principal maximum and the secondary maximum of the first frequency distribution, is less than a preselected, first difference threshold;
    - the absolute value of the difference in the position of the values of the vertical component of the

30 block-displacement information, which correspond to the principal maximum and the secondary maximum of the second frequency distribution, is less than a preselected, second difference threshold;
    - the principal maximum of the first frequency

35 distribution is greater than a first frequency threshold; and
    - the principal maximum of the second frequency

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distribution is greater than a second frequency threshold;

5   As an alternative to the block-matching method for an image region 6, 7, 8 in question, block-displacement vectors of a block-oriented image encoding method can therefore be used to determine the displacement of images in an image sequence, in order to reduce the computational time. For the block-matching method, a criterion was specified which is suited for

10   detecting local movements inside relevant image region 6, 7, 8, and is synonymous to the reliability of the regional-displacement determination not being sufficient. A criterion for detecting local movements inside relevant image regions 6, 7, 8 was likewise specified for the

15   displacement-estimation method using block-displacement vectors.

What is claimed is:

1. A method for determining a displacement (15) of images in
an image sequence, in particular for compensating for a camera
movement, a plurality of image regions (6, 7, 8) of the images
being available for determining the displacement (15), each
image region (6, 7, 8) being provided at a preselected
position of the images, and each image region (6, 7, 8) having
preselected dimensions, in particular, predetermined numbers
of pixels in various directions of the image, wherein an image
movement mainly caused by a camera movement is separated from
an additional movement, which is superimposed on the image
movement in subregions of the image to be corrected; using the
following steps:
- the probability of the image movement occurring
  without the additional movement is calculated at
  different positions of an image;
- for each image region (6, 7, 8,), the position and
  the dimensions are specified and fixed as a function
  of the probability of the image movement occurring
  inside the one image region (6, 7, 8) without the
  additional movement; and
- at least one image region (6, 7) out of the
  plurality of image regions (6, 7, 8) is
  preferentially used for determining the displacement
  (15).

2. The method as recited in Claim 1, wherein a first image
(14) of the image sequence is corrected by determining the
displacement (15), either from image data of the first
image-sequence image (14) and image data of a second
image-sequence image (12) that preferably precedes the first
image directly, or from image data of the first image-sequence
image (14) and image data of a second input (starting)
image-sequence image (11) that preferably precedes the first
image directly, a regional displacement of an image region (6,
7, 8) being utilized as a displacement (15), the regional

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displacement of an image region (6, 7, 8) of the plurality of
the image regions (6, 7, 8) either being determined from the
image data of the first image (14) and the second image (12)
inside the one image region (6, 7, 8), or from the image data
of the first image (14) and the second starting image (11)
inside the one image region (6, 7, 8).

3. The method as recited in Claim 1 or 2, wherein the position
and the dimensions of the at least one first image region (6,
7) are selected in such a manner, that the at least one first
image region (6, 7) of the images to be corrected is mainly
filled in by the image background.

4. The method as recited in one of the preceding claims,
wherein the position and the dimensions of the at least one
second image region (8) are selected in such a manner, that
the at least one second image region (8) of the images to be
corrected is mainly filled in by the image foreground.

5. The method as recited in one of the preceding claims,
wherein, in order to determine the displacement (15), the at
least one first and/or the at least one second image region
(6, 7, 8) is used as a function of a margin of reliability
(reliability factor) for determining the regional
displacement.

6. The method as recited in one of the preceding claims,
wherein two first image regions (6, 7) and an individual
second image region (8) are available for image correction,
the displacement (15) being determined in one of the following
three ways, in the order of descending priority:

- from the mean of the regional displacements of the
  two first image regions (6, 7), when the reliability
  of the regional-displacement determinations for the
  two first image regions (6, 7) is considered to be
  sufficient;
- from the regional displacement of one of the two

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first image regions (6, 7), in which the reliability of the regional-displacement determination is considered to be sufficient;

- from the regional displacement of the second image region (8).

7. The method as recited in Claim 6, wherein the method is used for a head-shoulder recording situation, the two first image regions (6,7) being selected to be in a lateral region, to the left and right of, and preferably symmetrical to the vertical center line of a predetermined rectangular image, the distance of the two first image regions (6, 7) from the bottom image margin being selected to be greater than the distance of the two first image regions (6, 7) from the top image margin, the second image region (8) being selected to be near the center of the image, preferably symmetric to the vertical center line of the rectangular image, and the distance of the second image region (8) from the top image margin being preferably selected to be greater than the distance of the second image region (8) from the bottom image margin.

8. The method as recited in one of Claims 5 through 7, wherein, for two image regions (6, 7), preferably the two first image regions (6, 7), the regional displacement and the reliability of the regional-displacement determination are determined by a method having the following steps:
- the regional displacement and a correlation quotient are calculated for each of the two image regions (6, 7);
- a threshold value function is determined as a function of each ascertained regional displacement of the two image regions (6, 7);
- each correlation quotient of one of the two image regions (6, 7) is compared to the value, which results from a threshold value function for the regional displacement of the other of the two image regions (6, 7); and

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- the reliability factor of the regional-displacement determination of each of the two image regions (6, 7) is viewed as being sufficient, when the correlation quotient corresponding to the one image region (6, 7) is greater than the value of the threshold value function to be compared to the correlation quotient.

9. The method as recited in Claim 8, wherein the correlation quotient of one of the two image regions (6, 7) is determined according to a method having the following steps:

- using a block-matching method, displacement-correlation values are determined for several possible regional displacements;
- the regional displacement, for which the displacement-correlation values are maximized, is regarded as the regional displacement of the image region (6, 7); and
- the correlation quotient is calculated by dividing the maximum displacement-correlation value by the mean of the determined displacement-correlation values.

10. The method as recited Claim 8, wherein, for each arbitrary regional displacement that is less than a preselected first threshold value, the value of a preselected second threshold value is assumed by the threshold-value function, and, for each arbitrary regional displacement that is greater than the preselected first threshold value, the value of the preselected second threshold value minus a product is assumed by the threshold-value function; the product including a preselected slope parameter and a difference as factors, and the difference being formed from the arbitrary regional displacement and the preselected first threshold value.

11. The method as recited in Claims 5 through 7, wherein block-displacement information from a block-based encoding

method is used for determining the regional displacement; for each of the image regions (6, 7, 8), the block-displacement information, preferably displacement vectors, of blocks lying inside the specific image region (6, 7, 8) being considered.

12. The method as recited in Claim 11, wherein a method having the following steps is implemented for each of the image regions, in order to determine the regional displacement, including a horizontal and a vertical component, and in order to calculate the reliability of the regional-displacement determination:

- in order to calculate the horizontal component of the regional displacement, a first frequency distribution is generated for the frequencies of different values of the horizontal component of the block-displacement information, the horizontal component of the regional displacement corresponding to the value of the horizontal component of the block-displacement information, at which the first frequency distribution assumes its principal maximum;

- in order to calculate the vertical component of the regional displacement, a second frequency distribution is generated for the frequencies of different values of the vertical component of the block-displacement information, the vertical component of the regional displacement corresponding to the value of the vertical component of the block-displacement information, at which the second frequency distribution assumes its principal maximum;

- the reliability of the regional-displacement determination is considered to be sufficient, when all of the following conditions are fulfilled:
  - the absolute value of the difference in the position of the values of the horizontal component of the block-displacement

information, which correspond to the principal maximum and the secondary maximum of the first frequency distribution, is less than a preselected, first difference threshold;

- the absolute value of the difference in the position of the values of the vertical component of the block-displacement information, which correspond to the principal maximum and the secondary maximum of the second frequency distribution, is less than a preselected second difference threshold;

- the principal maximum of the first frequency distribution is greater than a first frequency threshold; and

- the principal maximum of the second frequency distribution is greater than a second frequency threshold.

13. A device for determining a displacement (15) of images in an image sequence, according to a method as recited in one of the preceding claims, wherein the device includes a displacement-detection circuit (100), the displacement-detection circuit (100) determining the displacement (15).

Abstract

Proposed is a method for determining a displacement (15) of
images in an image sequence, and a device for determining a
5   displacement (15) of images in an image sequence, which are
specially used to compensate for a camera movement. A
plurality of image regions (6, 7, 8) of the images is
available for determining the displacement (15), each image
region (6, 7, 8) being provided at a preselected position of
10   the images, each image region (6, 7, 8) having preselected
dimensions, in particular, a predetermined number of pixels in
various directions of the image, and an image movement mainly
caused by a camera movement being separated from an additional
movement that is superimposed on the image movement in a
15   subregion of the image to be corrected, using the following
steps:
- the probability of the movement occurring without the
additional movement is calculated at different positions of an
image;
20   - for each image region (6, 7, 8,), the position and the
dimensions are specified and fixed as a function of the
probability of the image movement occurring inside the one
image region (6, 7, 8) without the additional movement; and
- at least one image region (6, 7) out of the plurality of
25   image regions (6, 7, 8) is preferentially used for determining
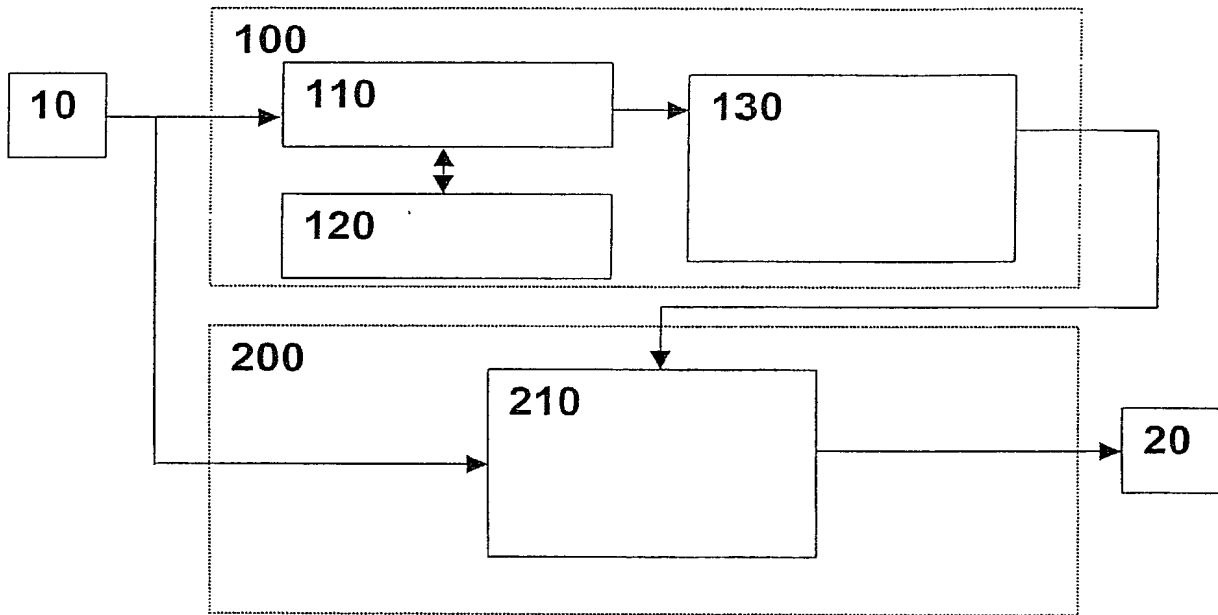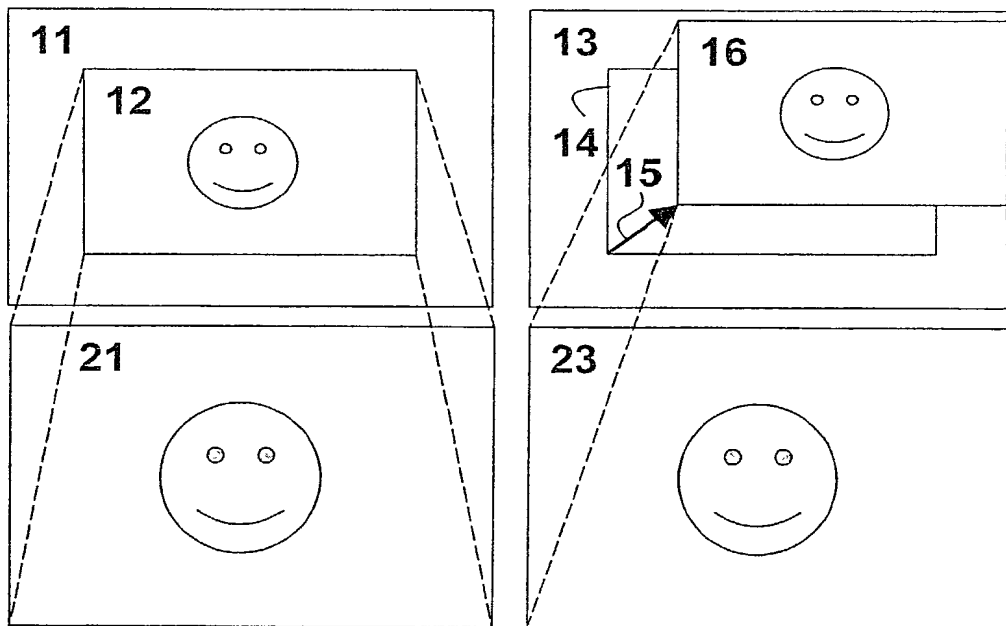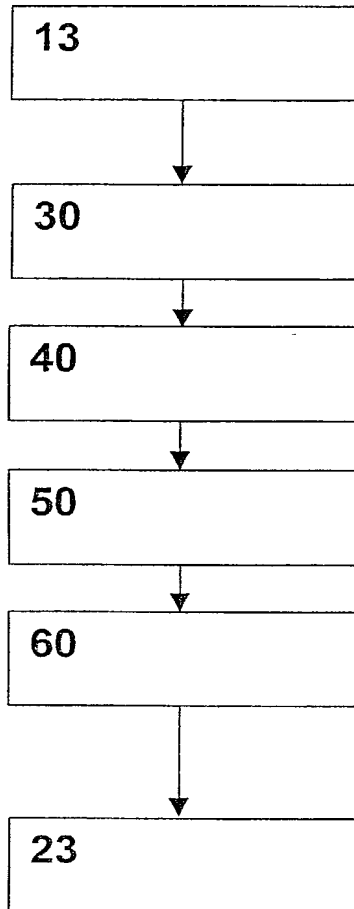the displacement (15).

(Figure 4)

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Fig 1

Fig 2

```
┌─────────────────┐
│ 13              │
└─────────────────┘
         │
         ▼
┌─────────────────┐
│ 30              │
└─────────────────┘
         │
         ▼
┌─────────────────┐
│ 40              │
└─────────────────┘
         │
         ▼
┌─────────────────┐
│ 50              │
└─────────────────┘
         │
         ▼
┌─────────────────┐
│ 60              │
└─────────────────┘
         │
         ▼
┌─────────────────┐
│ 23              │
└─────────────────┘
```

Fig 3

14

┌──┐
│ ┌──────┐   ┌──────────┐   ┌──────┐ │
│ │ 6   │   │ 8   │   │ 7   │ │
│ │   │   │   │   │   │ │
│ │   │   │   │   │   │ │
│ └──────┘   └──────────┘   └──────┘ │
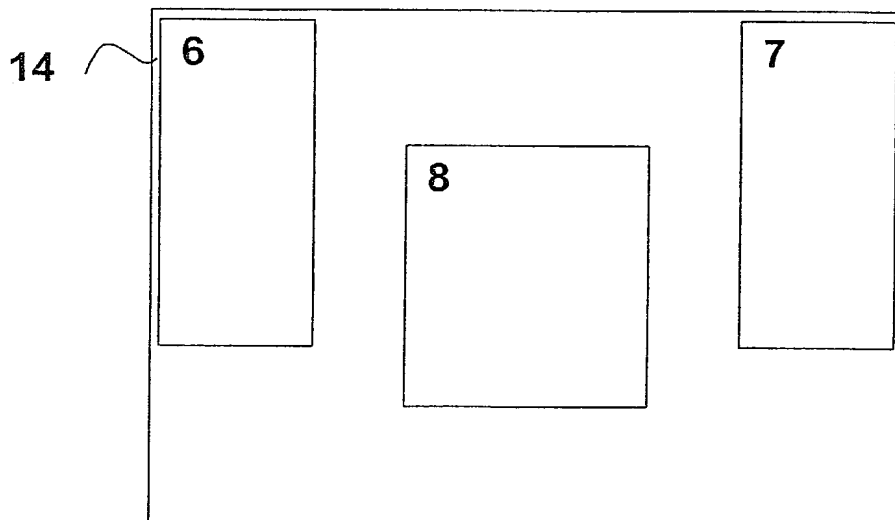└──┘

Fig 4

<u>DECLARATION AND POWER OF ATTORNEY</u>

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **METHOD AND DEVICE FOR DETERMINING A DISPLACEMENT OF IMAGES IN AN IMAGE SEQUENCE**, the specification of which was filed as International Application **PCT/DE00/00134** on January 15, 2000;

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

Number	Country filed	Day/month/year	Priority Claimed Under 35 USC 119
199 09 627.9	Fed. Rep. of Germany	5 March 1999	Yes

And I hereby appoint Richard L. Mayer (Reg. No. 22,490) and Gerard A. Messina (Reg. No. 35,952) my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful and false statements may jeopardize the validity of the application or any patent issued thereon.

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